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Cold Fusion and New Energy Technology

Volume 1, Nos. 5&6, Nov.1995 / Feb.1996

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Left, top: New type of anomalous excess heat reaction? **Right, top:** Patterson Power Cell demo at Power-Gen '95 **Middle:** Scenes from Power-Gen '95 exhibition in Anaheim, CA. **Lower left:** Electric scooter "powered" by Y. Takahashi's supermagnets. Photo: courtesy Sciex Corp.

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••SPECIAL NOTICE••

IF YOUR SUBSCRIPTION BEGAN WITH THE *PREMIER* ISSUE (MARCH/APRIL 1995), *AND YOU HAVE NOT YET RENEWED*, THIS IS YOUR LAST ISSUE of *INFINITE ENERGY!!!*.

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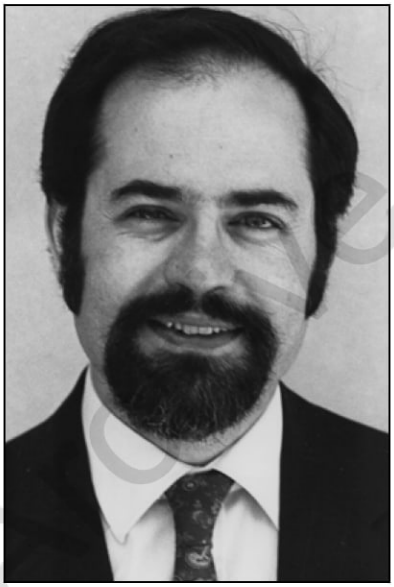
Photo of Joe Newman by Susan Leavines, Courtesy Evan Soulé

*In our Next Issue...**Joseph Newman and his Energy Machine**—*
Facts and Speculations About Electric Machines, Batteries, Theories, Patents, and Politics.

By Eugene F. Mallove, Sc.D.



Infinite in All Directions

One of our favorite people is physicist and man of letters Freeman J. Dyson of the Institute for Advanced Study in Princeton, New Jersey. Though Dyson, because of his high-profile, expansive thinking— receives a complimentary subscription to *Infinite Energy*, we have not yet heard his reaction to recent developments in the cold fusion/ new energy saga. Ironically, Dr. Dyson should be one of the first to speak up, for it might be said that he unwittingly heralded the now imminent energy revolution.

He wrote in his book, *Infinite in All Directions*, back in 1988, which was obviously before "CF Day," March 23, 1989 (the seventh anniversary of which we now celebrate):

"There is no reason why a new technology has to develop like fission and fusion on a thirty-year time scale. All it needs in order to go fast is small size of units, simple design, mass production, and a big market."

What a *perfect* description of cold fusion and related technologies and what is about to happen! Nearly a decade earlier he had written in *Disturb-ing the Universe (1979)*:

"To answer the world's material needs, technology has to be not only beautiful, but also cheep."

Both these sentiments were recalled in *Fire from Ice*, my account of the first two years of cold fusion. Surely, you were *not joking*, Mr. Dyson—to steal some fire from the title of the book of strange life adventures told by Dyson's late scientific colleague, Richard P. Feynman. (The latter suffered the great misfortune of having died B.C.F. — before cold fusion!) So, Dr. Dyson, *come on aboard* — and when you do, please let us have some eloquent words about the ostrich-like behavior toward cold fusion by your colleagues at Princeton, the American Physical Society, etc., etc.

The seventh anniversary of the Utah announcement is indeed here. Given the tribulations of the Cold Fusion War, it seems like a *century*. The day was nicely heralded by a close pass to Earth on March 23, 1996 by one of the brightest comets of record!

"Infinite in all directions," is an apt description of how the field of cold fusion and new energy is evolving today. For "mainstream" cold fusion we have the spectacular kilowatt-plus thermal output of the Patterson Power Cell, which was demonstrated last December at the huge Power-Gen '95 energy trade show in Anaheim, California. The power ratios were 1,000:1 or better. Actually, since many cold fusion phenomena (including Patterson's cell) exhibit "heat after death," i.e. heat production with no input power (once they get going), power ratios are effectively *infinite*.

The evidence of transmutations of heavy elements in cold fusion cells is now irrefutable, growing, and must be considered a serious piece of evidence for the explanation of the mechanism of "cold fusion." This is the "alchemy" aspect of cold fusion that infuriates so many establishment physicists—it gives DOE's anti-cold fusion hatchet man, John Huizenga, apoplexy! On this historic ABC television broadcasts about the Patterson Power Cell (February 7th, "Good Morning America" and "Nightline"), Huizenga exhibited signs of terminal confusion as he nervously repeated his nonsensical mantras of the last several years. Huiz-enga et al just can't tolerate the implication (now a *certainty*) that physics somehow took a very wrong turn in the first decades of the 20th Century— all textbooks are going to have to be rewritten to accommodate these strange phenomena.

As we went to press with this special Double Issue, a private meeting was being organized in Illinois by CETI (Clean Energy Technologies, Inc.), prospective corporate invest-ors, and Professor George Miley of *Fusion Technology* to discuss recently acquired evidence of element transmutations in the metallic coatings of Patterson beads from operated cells. With repeatable power production and sustained high power levels, it will be much easier now for experts to puzzle together the reaction pathways related to the enigmatic heat-producing phenomenon. Our regret, ex-pressed so perfectly by Jed Rothwell in his talk at our Cold Fusion/New Energy Symposium at the Cam-bridge Marriott last January (see his article on CETI in this issue), is that the field is being held back by highly restrictive commercial arrangements. *Right now*, instead of a mere handful of cells being placed with researchers signing non-disclosure agreements, there should be *hundreds* of Patterson Power Cells in laboratories around the world. The cold fusion controversy would thus be nearly over.

Fortunately, CETI and Patterson's cell are not by

Why We Donated $4,000 to Cold Fusion Technology to Help Fund This Magazine
by Dr. Bob & Zoh Hieronimus

In 1990, Hieronimus & Co. began a series of shows on Alternative Energy in hopes that the Gulf War scenario would never be repeated. In 1991 Dr. Eugene F. Mallove joined us for the first in a long series of programs updating our listeners on the success of Cold Fusion research and its applicability in every sector of our collective and personal lives. We are enormously impressed with Dr. Mallove's research, integrity, and courage of convictions and are proud to link our name with him and his publications. It is a great honor to contribute to his noble efforts and ***we urge all readers who want to preserve a better life for their loved ones, family and future generations to demonstrate their support by purchasing numerous subscriptions,*** video and audio tapes and other items from Cold Fusion Technology, and pass them on to their circle of friends and colleagues.

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any means the whole picture. Dr. Randell Mills of HydroCatalysis Power Corpora-tion in Lancaster, Pennsylvania has left ordinary water electrochemistry far behind. His company now has high-temperature hydrogen *gas-loaded* cells that work repeatedly at fossil-fuel combustion temperatures and power densities. HPC appears to be well-funded, well-staffed, and organized to bring out commercial products —self-sustaining electric generators— in the next few years. Perhaps Piantelli of Italy, supported by automotive giant, Fiat, will be neck and neck with Mills in his group's metal/gas cold fusion cells. Let's hope that the spirit of competition will spur CETI, HPC, Piantelli and others to greater disclosures. The new energy pie is *very large*— no need for any one entity to try to claim 100% market share, especially when patent protection is already in place.

And now for that most infinite of all directions: magnetic motors that are pre-sumptively "over unity." Tests at two independent U.S. laboratories with solid reputations have now confirmed the extraordinary performance of the Y. Takahashi permanent magnets. These patented magnets appear to violate all the known rules for permanent magnet formulation—achieving so-called BH-products of up to 200 MegaGauss-Oersteds (MGOe). Top-of-the-line permanent magnets are extraordinary if they achieve BH-products of 50 MGOe. These "Y.T. Magnets" were not supposed to be possible.

In specially designed electric motors, these magnets appear to produce astounding effects—*unthinkable* effects. Some of the effects that we know about from the lab experiences are giving researchers there sleepless nights—that's why they wish to remain anonymous for now! And, when these magnets are used in specially designed motor/generators, after they have been started by chemical electric storage batteries, they literally run on their own and power automobile headlights. Of course, *not one second* of such outrageous performance should occur, but the lights remain lit for over 10 minutes of the demonstration— with no end in sight. Sorry, we had to say it! In this issue of *IE* our sane and still skeptical Chris Tinsley recounts his experiences with Dr. Takahashi, his motors, and a retrofit electric scooter. Our opinion is this: it is either *the real thing* or *fraud*. With the background of a man like Dr. Takahashi (see his C.V. inside), his confirmed revolutionary magnets (with U.S. and international patent protection), what would he gain by conducting bogus demonstrations before University professors and hard-nosed engineers?

Last, but not least of this month's infinite directions, consider that a group of self-funded investigators in Ohio -"The Cincinnati Group"— appears to have developed a very high temperature "cold fusion" process using DC or AC electrical input that literally can melt and boil ceramic tiles. We have seen this process first hand— we have independently done it ourselves— and continue to be amazed at what it can do so easily. The materials that allow the process to occur are astonishingly specific, but once the right materials are used, it works every time! (For now we are under non-disclosure agreement with the Ohio group, but we hope to be public with more specific information in the future.) Unfortunate-ly, the calorimetry of this process is not easy, though some HVAC people called in as consultants have measured power ratios on the order of 10/1. But remember this: it is over 1,000 °C!

This is not the end of the "miracles" of the New Energy Age....There is much more to come. Enjoy!

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An Open Letter to Nobel Laureate Norman Ramsey

13 March 1996

Professor Norman F. Ramsey
Lyman Physics Laboratory
Harvard University
Cambridge, MA 02138

Dear Professor Ramsey,

Several years ago, I sent you a copy of galley proofs of my paper, titled "Sun-Induced Variations in Time in the Global Positioning System." Although I am writing to you now for an entirely different reason, I am mentioning this correspondence because my motivation for writing to you now is similar to my motivation for forwarding a copy of my paper then. At that time, as a common courtesy, I felt motivated to bring to your attention an error associated with a scientific paper (*Astrophys. Space Sci.* 6, 13 (1970)) by you, Daniel Kleppner and Robert Vessot, and to provide information about effects, which had been ignored, that illustrate the impact of this error. My motivation for writing to you today also is to bring to your attention an error and to provide information that illustrates the significance of this error. The situation is really very different however because the implications of the error in your earlier scientific paper are not nearly as profound as the implications of the more recent error that has motivated me to write to you today.

The error that I wish to bring to your attention is associated with the common misrepresentation that seems to be prevalent in discussions of the report by the 1989 DOE Energy Research Advisory Board concerning Cold Fusion, and the impact that this misrepresentation has had on the funding of Cold Fusion. As I know you will remember, this report did not recommend abandoning funding of Cold Fusion but recommended that DOE provide limited support to groups that had reported positive findings. However, de facto, with the exception of some limited funding by DOE of neutron-related work, funding was abandoned, and with time, the report was cited as justification for completely abandoning funding of the area.

A potentially remarkable irony is that although there does seem to be a very low-level effect involving neutrons, this effect is really very inconsequential. On the other hand, there is a very credible case that there is a very real phenomenon, the generation of large amounts of excess heat, that accompanies very high loading (x->l) in PdD_X, associated with Cold Fusion experiments. This phenomenon was largely misunderstood for a considerable period of time, primarily because it is extremely

Prof. Norman F. Ramsey Former DOE 1989 Cold Fusion Panel Co-Chairman, who tried to resign from the Panel because of its unwarranted intended 100% negative conclusion.
(Courtesy Harvard University News Office)

difficult to load D into PdD_X when x exceeds ~.7 and because to accomplish this typically requires many, many hours of sample preparation. There is also an evolving literature that indicates that the reason for the excess heat is of nuclear origin but that the associated reaction does not release any high energy nuclear by-products.

I am enclosing a number of documents that you might find of interest with regard to the Cold Fusion controversy in general, and in particular as it relates to the points I have raised. These include copies of a brief review article by Edmund Storms (a recently retired electrochemist from Los Alamos National Laboratory), and a series of articles summarizing some important work that has recently been carried out in Japan. As I said, there is also an evolving literature that indicates that the reason for the excess heat is of nuclear origin but that the associated reaction does not release any high energy nuclear by-products. The most important of these results are measurements of ^4He, which even as early as 1991, have indicated that nuclear ash, provided by some form of D+D->^4He reaction can be identified as the driving mechanism that is responsible for the excess heat. Complicating the identification of these ashes has been the fact that they do not seem to be readily identifiable except in areas outside heat-producing electrodes. An important reason I am including the Japanese results is that they include information about a new set of experiments (associated with a new form of geometry) where there is very significant (in fact very difficult to refute) evidence of ^4He being trapped (at levels consistent with the observed heating effects within heat-producing electrodes.

There is an additional irony associated with the Cold Fusion situation. It really does seem that physicists have played an important role in obfuscating the relevant facts, possibly because of the fact that the name "Cold Fusion" uses the word "Fusion." In particular, because "Fusion" unfortunately is part of the name, most physicists seem to have assumed from the outset that conventional fusion must be involved. This has led to virtually an almost completely unavoidable problem because of the very specific signatures that are commonly associated with fusion. It is my own view (based on my experience working with hydrogen-in-metals) that solid state effects are intimately associated with the excess heating phenomena. In particular, an evolving literature exists that indicates that under the special circumstances associated with the electrolytic experiments, there is good reason to believe that both deuterium and hydrogen will be favored energetically to occupy "ion band states" in which each nucleus effectively dissociates from its electrons. In the peculiar situation in which a macroscopically infinitesimal (though microscopically large) number of D^+ or H^+ ions occupy these kinds of states, it does become possible for alternative forms of nucleus overlap to occur in bound solid state environments. I am enclosing a copy of a recent mailing that I have distributed to a number of condensed matter physicists concerning my opinions about this, along with accompanying copies of abstracts of posters that Talbot Chubb and I will be presenting at the March, APS meeting, in St. Louis.

Finally, I do realize that Julian Schwinger was your dissertation advisor, and I am certain that you are aware of his involvement in the Cold Fusion controversy. Because of this fact, I have included a final enclosure, a copy of a letter to the editor that I have prepared for *Physics Today*, which I thought might be of interest to you.

As I said, my motivation for writing to you is to bring to your attention a serious error associated with the misrepresentation of the ERAB report and to provide information that illustrates the significance of this error. Of the various enclosures included in this correspondence, I wish to draw your attention specifically to the distribution list that I have included in my recent mailing (to *Condensed Matter Physicists)* that advertises our APS meeting abstracts. Three individuals on this list, Dr. Eugene Mallove, Dr. Melvin Miles, and Professor George Miley have been very much involved with issues related to the generation of excess heat. And I know that any of them would be pleased to share with you information about their experiences with excess heat related phenomena. Also, please do not hesitate to contact me about these and related issues.

Sincerely Yours,
Dr. Scott R. Chubb, Code 7252
Naval Research Laboratory
Washington, DC 20375-5351

XC: Dr. Eugene Mallove, Dr. Melvin Miles,
Professor George Miley

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• The FIRST ANNOUNCEMENT •

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Oct. 13-18, 1996 Hotel Apex Toya, Hokkaido, Japan

Sponsor: NEDO NEW ENERGY AND INDUSTRIAL TECHNOLOGY DEVELOPMENT ORGANIZATION

GENERAL INFORMATION

Date: October 13 (Sun.)- 18 (Fri.), 1996 **Venue:** Hotel Apex Toya, Hokkaido **Official Language:** English **Sponsored by:** New Energy and Industrial Technology Development Organization (NEDO)

PRE-REGISTRATION

Participants are kindly requested to indicate their interest by filling out the attached pre-registration form. Further information concerning the ICCF-6 will be sent to those who have expressed their interest by completing the pre-registration form.

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SCOPE OF THE CONFERENCE

The object of the conference is to stimulate discussions on subjects related to the so-called COLD FUSION phenomenon. The conference has a scope to provide an international forum for the discussion of the most recent and academic aspects of the research.

TOPICS

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- Correlation Between Excess Energy and Nuclear Products (Experiments and Theory)
- Nuclear Physics Approaches (Experiments and Theory)
- Material Science Studies (Experiments and Theory)
- Innovative Approaches (Miscellaneous Phenomena)

PAPERS and PROCEEDINGS

The ICCF-6 will include contributed and invited papers which will by presented in plenary, oral, and poster sessions. Papers to be presented will by from peers of the Program Committee and selected on the basis of submitted extended abstracts. The details on the extended abstract will be informed in the second announcement; call for paper. The final manuscripts will be published after a review by peers.

FURTHER SCHEDULE

Issue 2nd Announcement: February 1996 DeadLine for Abstract: May 1996

TECHNICAL TOUR and SOCIAL PROGRAM

Technical tour to the NHE-Lab. and other events, and a fantastic social program will be scheduled.

SPECIAL INFORMATION

The local organization committee plans to support young researchers and students financially for the easier attendance to the conference.

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CORRESPONDENCE

Please address all correspondence to:

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Oct. 13-18, 1996
******ICCF6******

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LETTERS TO THE EDITOR

I have enclosed my check to renew my subscription. I would like to say that in all my years I have never obtained so much valuable and useful information for so little cost as from your magazine. Finally, I perceive a clear path to freedom. Fleischmann and Pons should receive Nobel prizes in chemistry, physics, and peace.

Robert Mockan
Northridge, California

●

Superlative, riveting read!! Whilst at a friend's house this weekend, I was introduced to your publication and am writing to thank you so much for your courage and scientific integrity in bringing this knowledge to the forefront.

I am 23 years old and am starting Mechanical Engineering this year, therefore graduating in the year 2000, and reading about the research you publish in your journal gives me fresh, continued hope.

It is a breath of fresh air to read that nothing will stop great discoveries or great men from achieving their dreams.

The cobwebbed halls of Academia, industry, and politics allowing the almighty dollar to hold a gun to their heads will have to recognize the irreversible winds of change.

Bohr, Einstein, Planck — your time came and now is gone. You shattered icons yourselves and thus *we* also have to recognize that knowledge is progressive—ever changing. We stand on your shoulders and look upward.

An exciting time unfolds ahead of us if we are men enough to keep spreading the truth and strong enough to embrace trhe ansers. Carpe diem.

Journals of your caliber are a rarity.

David Mason
Duncan, British Columbia
Canada

●

Enclosed is a check for $29.95 to renew my charter subscription to INFINITE ENERGY magazine. Your timing in founding the new magazine was excellent.

1995 will go down in history as a turning point for CF. Once again, you and your colleagues have done a fine job in reporting the field, which needs a magazine like INFINITE ENERGY. Con-gratulations in surviving the first year of a new venture, and all the best for 1996.

Thomas Stolper
New Haven, Connecticut

●

Thanks for the first four issues of Infinite Energy. You have done a really fine job of mixing science with practical information.

The notes of Julian Schwinger [Issue #1] were especially informative. Funny how a top flight physicist can go afoul of the "Powers that Be" by looking at the wrong thing.

Best wishes. Keep up the good and very important work. Sign me up for another year.

Fred Y. Durrance
Houston, Texas

●

I went down to the local library yesterday to inquire as to the possibility of me getting them a subscription to Infinite Energy, and they said yes. I am therefore buying them a year's subscription, for which I am enclosing a check for $29.95. Could you all remind me a year from now, to renew the subscription if they do not do it themselves? Thanks!

Edward E. Rom
Mankato, Minnesota

[Ed. Note: The library is Minnesota Valley Regional Library]

●

(via Internet)

I am a fourth year Materials Engineering student at the University of Alberta, Canada. My interest in the area of cold fusion was recently peeked when I realized the level of work going on this field. The professors here at the U of A seem to take the attitude that cold fusion is a bad gag, and that it was shown to be wrong. Some even laughed at me when I mentioned cold fusion. An interesting note: about 10 years ago S. Pons was doing research here at the University of Alberta (although I don't think it was in the area of cold fusion), he of course left to go to Salt Lake City to research there.

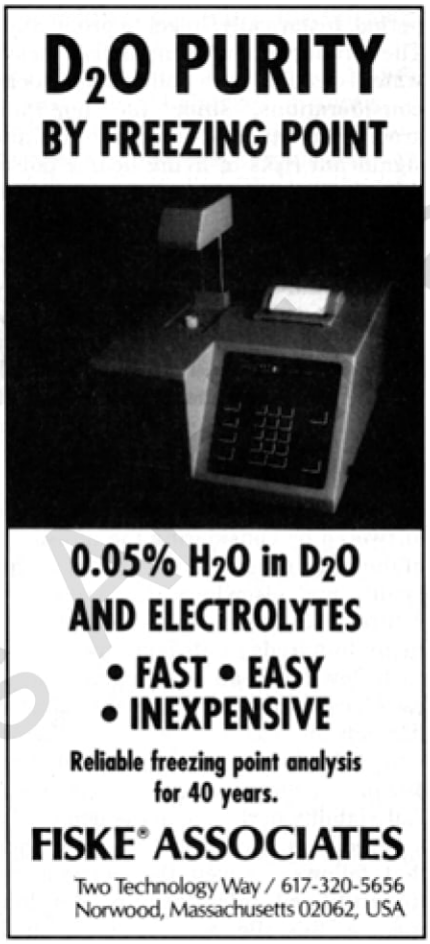
I would like any information on the topic of cold fusion and how to set the experiment up. Information on procedure, preparation, and materials needed to make the set up run would be useful. If you don't have all the info, maybe you could tell me where to find it.? Thank you for your help and time.

Kelly Schoof (Materials - Metallurgy Engineering)

●

I was pleased to read your posting of the Cold Fusion Technology Extract, announcing your new publication. Having read this, I once again became aware of the strategic role that heavy water might play in future cold fusion developments.

Probable developments in the realm of cold fusion suggest that large quantities of heavy water will be required in the next five to ten years to make this technology a commercial reality, yet at this very moment the remaining production capability of the world's largest and most reliable producer is irrevocably threatened by a stagnant growth nuclear industry. In only a few months time, a final decision could be made to abandon or not the fourth and final unit of the Bruce



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Heavy Water Plant, located in Ontario, Canada.

This decision could needlessly set back the rapid introduction of cold fusion technology in the next decade. Other sources of heavy water are available, and other plants can be built, but it takes at least a five to seven year lead in period, historically, to get to production. The production of economical heavy water is frought with political and social considerations, since the populace around a plant must accept the real and significant risks of living near a poisonous facility, that commonly uses H_2S or NH_3.

At the present time, we must ask who will take the leadership role to preserve this asset, ultimately needed for the rapid expansion of the embryonic cold fusion industry. Without ongoing cash flow, the present facility is threatened, as is every other competing facility in the world that relies on a market economy.

The question of cash flow might be answered by considering the utilisation of the large production inventory at this facility and elsewhere. Currently, this future use inventory, amounting to many hundreds of Megagrams, is, on a cash flow basis, an unproductive interest charge. By balancing this charge, through the leasing of water, or the in-situ cold fusion generation of heat (steam) or electrical energy, the financial viability of the facility is potentially assured over the critical 5 year period that follows. Given the outstanding, under-utilized infrastructure development at this site, any proposal which can generate a viable per annum cash flow of $40 to $60 per kilogram of D_2O will succeed, I speculate.

In my opinion, daring, entreprenurial proposals are required now, to make use of this stagnant resource . The failure to do so will result in the requirement of additional billions of dollars in investment capital to replace the now existing infrastructure. (If individuals or organizations are interested in pursuing proposals, I will gladly forward these contacts.)

Lionel Berry

●

(via Internet)

I am interested in the possibilities for new technologies surrounding the "Cold Fusion" phenomenon. I am eagerly awaiting the information that will come from your [Cold Fusion/New Energy] conference January 20th. What I am immediately interested in is this, and perhaps you can help, if you will. First a little background. I am NOT a scientist by any stretch. What I am is ex-navy-radar technician, ex-defense industry, ex-controls industry, now present semi conductor industry technician/engineer want-to-be.

I'm presently taking pre-engineering classes at the local community college I have a lot of mechanical and electrical skills that I would like to utilize in an endeavor that would help to solve some problems converting this new science to a commercial application. (Just like everyone else!!!) I have web-searched lots and lots and have found much information. What I have not found, is this: What mechanical or electrical obstacles need to be overcome in order to make this a useable thing. I cannot find ways to increase reactor outputs. That's not my field.

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What I can do is move things with electricity. I know this is kind of vague, but I feel that I can make a contribution to this effort in some way, if only I knew where to start. Are there mailing lists? Magazines? Discussion groups? I want to be involved in this terribly exciting thing that in my humble opinion will change life on our planet as we know it. Any information or guidance would be greatly appreciated.
Thanks Doc....

Sincerely,
Joseph C. Price

●

(via Internet)

My name is Chris Anderson, I'm an Undergraduate Research Assistant at the Milwaukee School of Engineering's Rapid Prototyping Center. I'm an undergraduate in Electrical Engineering. The other members of our group are in Mechanical Engineering. We wish to attempt to build and test a Patterson Cell. We've researched the device itself, and we were wondering if perhaps you knew of a reasonable source for palladium metal. We wish to do our own electroplating. I've tried Sigma Chemical and havent gotten any response, and the other supply houses either didn't have anything, had it at truely excessive cost, or wouldn't sell and in relatively small amounts. Could you send me any info you might have on sources?

We hope to build a cell, and once we see it work, we hope to build a second cell, with proper documentation and testing.

Thanks for your help.
Chris Anderson
Nathan Woodruff
Chris Jones

●

(via Internet)

Issue 4 now in hand and my breath no longer bated. Very good content, the promise of the magazine being fulfilled. Please extend my subscription using my credit card number you have in hand.
The over-unity motors boggle me more than the electrochemical cells, probably because my training is in electrical engineering. I was not able to make much sense out of Werjefelt's presentation at MIT. Not only were the concepts unfamiliar, but his terminology was also, since he comes from outside the electrical engineering community and there often is no good language to describe something totally new.

The Kawai configuration is not the first to claim energy extraction from magnetic fields, but it may be the first to have visible industrial backing. I have at hand 'The Free-Energy Device Handbook' from Adventures Unlimited Press, compiled by David Childress. (ISBN 0-932813-24-0) It is an eclectic collection, including Faraday homopolar machines, the Adams pulsed electric motor generator, an evaluation of the Sunburst homopolar generator (an invention of Bruce DePalma) by Kincheloe (Stanford Prof. EE Emeritus), and a statement by Dr. Hastings to a congressional committee reviewing the Newman machine. In addition, there is a collection of patents on machines purporting to extract energy from magnetic fields. There is a bit of spookiness of suppressed inventions about some of the accounts.

Rothwell's observation about the narrowness of focus of CF scientists and critics is appropriate and understandable; you have to be narrow to dig deep, but your borehole might be inches off the mother lode. What boggles about the magnetic devices is that there is no energy source in sight; $E=mc^2$ will cover the nuclear processes, but there isn't anything but the vacuum energy to avoid an apparent violation of the conservation laws.

As an aside, Asimov wrote a story with the title *The Gods Themselves*... (or something like that) in which scientists discovered a wondrous new source of safe energy and were going wild with it, until too late they discovered that it was tearing at the fabric of the universe itself.

There are some reports that the rate of radioactive decay is not a constant for each isotope, but is affected by the ambient electric field. The Earth itself sits in a potential well. If that well is perturbed so are the carbon isotope dates, which are important in some fields of 'speculative' history and archaeology.

Regards, Mike Carrell

●

(via Internet)

In our possesion we have today a very promissing patent covering the knowledge of how to build a small generator (reactor) based on the fact that a flash of lightening is creating a very high temperature, enough to get the cold fusion started and to maintain the process.

As Sweden is a small country, however with a lot of well reputable scientists, as you probably know, there are not enough funds to develop this process. The Swedish Nuclear Research is today focusing on other projects and cannot be further split up.

We are looking around to find people, Governments, companies, or organisations that might be interested in this project. We are going to place the patent in a Swedish official company in which we will offer the partners to participate and to hold 50% of the shares (negotiable).

The patent has been scrutinized by professors at Chalmers Institute of Technology in Gothenburg, Sweden and has been found very promissing and with high credibility. [We have a] program to build a generator and to run the program for 1-2 years.

Can you give me some ideas about potential partners?

Jan W. Kjellberg
Sweden

●

I am a final year undergraduate chemistry student at the University of Man-chester Institute of Science and Technology (U.M.I.S.T.) in the U.K. I have been assigned a project on the subject of Cold Fusion and have been given various citations to use as starting points. My problem with this is that every citation is heavily biased towards dicrediting the research and work into Cold Fusion. I have read *'Fire from Ice'* and found it to be well balanced, showing both sides of the story. But seeing that you are now heavily Pro-Cold Fusion, I would be interested in finding out what changed your point of view, and also if there are any recent (1994-1995) developments that will help me to give a more evenly balanced view of the progress made into Cold Fusion research. I am sorry for any inconvenience caused by this rather unorthodox request, but thank you in advance for your time and any reply.

Carl Mark Windsor

●

I would like to take this opportunity to thank you for publishing my article in the July/August 1995 edition of *Infinite Energy*. It is very significant to me that I have had a reporte published in a magazine, even though I am only a senior in high school. I appreciate your acknowledgement of my research as well as the information you have sent me. I hope your magazine continues to do well and the acknowledgement of cold fusion as a possible process continues to grow. Again, thank you.

Michael P. Belcher
Princeton, West Virginia

●

(via Internet)

My company is in need of a 1 kw cold fusion-electric generator for use in a orbital tug we are currently developing. How can I get in touch with the sales/marketing staff at CETI?

Thank you for your efforts.

Mike Lorrey

●

New Energy Times Archive

I have visited the WWW and read the reports of SOFE '95 and the Power Gen. demonstration. I have been interested in CF for five years and have had a difficult time to get information on it, because not much news [about CF] is on major media. I am a Japanese student at the University of South Alabama. The Japanese are more enthusiastic about [this] energy source than Americans, because we have virtually no oil and very few coal mines in our country. Also, air pollution and water contamination are more serious problems than those in this country, since Japan is a small island and the population is denser. Solar cells are coming into practical use in my country. By the same token, CF, if it will be in practical use, may benefit us a lot. Honestly, I am not certain about CF, but I am sure that something that cannot be explained by existing physics theories is happening. It is reasonable to spend couple of million dollars on CF research in case it is real because the stake is too high and the reward is too much to ignore. CF can change the world fundamentally so a few mllion is not a bad investment, even though it might be wasted. Hot fusion research has been spending many times more than that and will eat more.

Unfortunately my major (and profession) is computer science, neither physics nor chemistry. I cannot participate in the experiments, but I will continue to watch CF. The magazine will help me catch on.

Kazuyoshi Onuka
Mobile, Alabama

●

It is with pleasure that I renew my subscription to IE. It and related materials have certainly changed the way I think about things and spend my spare time. I state sincerely that if your publication and others like it were to cease, the potential loss to humanity could be very great. The quality of yours in particular is admirable, considering the limited extent that such a publication can penetrate a public glibly content either with the illusion of security that ignorance provides or the dis-/mis-information and extreme understatement in these matters provided by the scientific establishment and media.

A few comments that may warrant your attention. While describing the Yusmar to a fellow employee who was particularly interested in Jim Griggs' ultrasonic cavitation devices, I mentioned that in tests in the U.S. the device did not perform in an above-unity manner. Immediately, he suggested that it was perhaps due to the difference in elevation between test sites, since he had experience with a boat propeller that cavitated severely when he used it— that did not cavitate at a different elevation. I don't remember the articles describing the testing of the Yusmar in *IE* #3 mentioning anything about gas pressure, although it is listed as a critical parameter in Stringham's ultrasonic cavitation device.

The same fellow worker and I share an avid interest in electric cars, although he is more current on recent technological advances. Being consumers of such information, our hopes are often raised and lowered by statements about advances in new technology, so we both tend to be skeptical. I have a greater training in physics and engineering and tend to take at face value the statements that qualified scientists make about mechanical-electrical-chemical energy equivalencies. I have learned to accept energy conversion constants without question. He, understandably, balks at the over-unity claims and asks, in so many words, "Compared to what?" Using as an example, the improved wood stoves of the past that gave more complete combustion, he says, "Isn't it possible that these new devices are just getting more energy that was there all the time?" Well, that is just the point, the energy is coming from somewhere, but for the moment, the imperative is on *coming*, not on *where*. The better our theory, the better our machines will be, but if we do not build useful machines, profound discoveries fade into disfavor. "Tesla was a dreamer," I was told as an engineering student, as if that fact nullified the greatness of his discoveries.

Most people miss the significance of free energy almost entirely. When I explain CF cell calibration with a pure resistive load and the loss of energy through an open cell's release of the products of an energy-consuming hydrolysis reaction, accompanied by a net higher cell temperature for a given input power than the calibration point, my friend's interest is raised. Edmund Storms made very valid points about people's approach to the unknown. If a person starts with the belief (perhaps unconscious) that something not already accepted is false, it is only reasonable to expect perhaps severe resistance to strange information. Crudely put, most people will dread what they do not understand and fear what they cannot control, and often try to destroy or ignore both. What cannot be conveniently ignored or destroyed or understood is revered and imitated, after a period of cognitive dissonance. Somewhere in there some learning can take place sometimes. Getting past that ignorance barrier can be difficult, but that is the task you have chosen. To paraphrase a Buddhist proverb: "The beginning of knowledge is the admission of ignorance."

Dr. David Deak's interesting article on possible uses for the very novel ultra-sonic levitation technology missed a ccnceivable use. CETI may find a mult-node sonic chamber to be a good place to uniformly sputter the palladium and nickel coatings on the tiny spheres used in their devices, particularly if the rotation of the spheres is controlled as described by the author.

Being trained as an electrical engineer, I am particularly taken with Bertil Werjefelt's magnetic battery. I ordered a copy of T. Kawai's European patent application and the UK patent application submitted by H. Aspden and R. G. Adams for similar devices. These are quite informative, if somewhat terse reading. The redundancy and recapitulation practiced in the writing of patents in order to blanket conceptual material can be confusing. Learning that a U.S. patent has been granted for the device is thrilling, but what became of Werjefelt's U.S. patent claim?

I suggest that you request that B. Werjefelt allow a reprint in *IE* of his layman's explanation that was printed in *Extraordinary Science*, April/May/June, l993. Either that or a complete explanation of the devices described in the patents mentioned above, written by someone who has your penchant for clarity, and includes computer artistry like Dr. Deak's. The hours I have invested reading these patents has been well rewarded and I daresay that the concepts are not that difficult to grasp (of the ones I have succeeded in comprehending), but the linkage to Carnot engine efficiency alluded to by H.Aspden to explain extraordinary efficiency by using ZPF 2.7K temperature for "exhaust" is a bit of a stretch to my thinking. Is magnetic energy supposed to be tapping a virtually infinite highly-energetic subquantum sea in which we are immersed or have we found a near infinite thermal dump, or waterfall over which a "head" of energy flow (to borrow the hydrodynamic analog) can fall to hit our turbines? This would be good science fiction were it not for the claims of actuality that make it astoundingly alleged fact. I use 'alleged' advisedly to retain my claim on the term empiricist. I am not endlessly skeptical, but I have not yet witnessed these things. I am not a disbeliever, I am a seeker after truth.

I make these points about speculation and comprehension in hopes that in the future *IE* would hold more attraction to people like the ones I

New Energy Times Archive

work with. People with more practical knowledge than theoretical knowledge, who are curious enough to look at a copy of *IE*, but not interested enough to purchase a subscription.

I learned from Jim Griggs in a conversation some time ago that he has news that a 3/4 H.P. motor built on these principles has been marketed in the U.S. Any word on independent field

In my studying of science from a very young age, I dreamt of discovery. As I grew to know how rare profound scientific discoveries are, I envied those who were fortunate enough to live at a time of scientific revolution. I somehow did not ever consider that I would find myself in the middle of one. The rules are changing.

Best wishes in what promises to be a year at least as exciting as the last.

Ed Wall
DOT/FAA/ASW-455
Ft. Worth, Texas

●

I want to congratulate you for presenting such an enlightening program on Cold Fusion and New Energy yesterday in Cambridge [Ed. Note: January 20, 1996, Cambridge Marriott hotel. Tapes of the day-long Symposium are available. See ad in this issue.]. The number of attendees was much greater than at the recent one you organized in New Brunswick [New Jersey]. The change in locale had much to do with it, or perhaps the word is getting out that there is something to Cold Fusion. Dr. Swartz's work will help to dispel much of the notion of fantasy because of the non-reproducibility of the early experiments on cold fusion.

John W. Soehngen
Cranbury, New Jersey

●

Please enter my renewal subscription to Infinite Energy for an additional year.

I plan to send three or four names of possible subscribters, but feel it more effective to give them just a bit more solid evidence from the ongoing record, as they are all very orthodox physicists.

Your publication is very well done and quite stimulating. I've been a silent supporter of Pons and Fleischmann, almost from the beginning. It seemed clear from their first experiments that they were getting surplus energy, never mind whether there was a nuclear reaction or not. I still have clippings from those days and remember well their humbling experience at UCLA.

Also enclosed are the names of two potential subscribers. One is an old friend who is a retired Air Force pilot like myself and who is finishing a career as a physics teacher. The other is Amory Lovins, the noted author, lecturer and consultant on energy conservation issues. I have not spoken to him in many years, though I once had the pleasure of introducing him to a mathematical group at the Boeing Company that did energy simulations for utilities. He should be very much aware of the breakthroughs in cold fusion, but in the last interview I heard on NPR [National Public Radio], he was still espousing his traditional energy message, with no apparent awareness of these new trends. I will drop him a note recommending your journal. Lovins has contacts all over the world and would be a valuable disciple.

R.C. Slate
Seattle, Washington

●

Dear Gene,

Please keep up the good work and the good fight. Most pioneers and revolutionaries endure trials that other "stay at homes" never dream of. Yet as your New England forefathers said, "Progress depends on unreasonable people."

Best wishes,
Geoff Rohde
Davis, California

●

While we appreciate your generous offer [Ed. Note: An anonymous contributor to *IE* made this possible!] of providing a year's subscription to "Infinite Energy" for our periodical collection, we have decided not to add the title at this time. As you can probably surmise, an additional periodical title is not a one time, one day chore, but rather a long term investment for the library. This investment includes cataloging costs, upkeep, future storage, micro fiche or film charges if applicable, etc.

While I realize this decision will not be completely satisfactory, I am also sure you can appreciate the challenges in providing a wide selection of materials for our diverse community within budgetary constraints.

Thank you for your understanding in this matter.

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Librarian, Denver Public Library

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The author, Frank Znidarsic, has a B.S. in Electrical Engineering from the Unviersity of Pittsburgh, has an Associate in Science from Saint Francis College, and is a registered professional engineer in the state of Pennsylvania.

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• Dr. John Bockris, Texas A & M, shows calculations of the effects of high fugacities (internal pressures) on the metal lattice and also describes his latest electrochemical experiments, which produced over 30 Megajoules of excess heat per mole of palladium.

Tape Two—Two, One-Hour Roundtable Discussions

• "Similarities and Differences in Cold Fusion Experiments," chaired by Dr. David Worledge of the Electric Power Research Institute. Panelists include Drs. Stanley Pons, Hideo Ikegami, Melvin Miles, and X.Z. Li.
• "Cold Fusion 1992: Where Do We Stand—Where Do We Go." chaired by Dr. Martin Fleischmann. Panelists include Drs. Vladimir Tsarev, Fritz Will, Michael McKubre, Giuliano Preparata, Robert Huggins.

The results presented at this conference were historic. They dispelled any remaining doubts about the reality of Cold Fusion and the convincing evidence of its nuclear nature. The conference should have been front-page news across the globe. However, the popular media decided to not report the events at this conference. These tapes are the only video record of the event.

These video tapes, which were edited and originally sold by Nova Reources Group, Inc., are now available exclusively through Cold Fusion Technology. To order your set of ICCF2 Tapes, send check or money order for $165.00 (U.S. and Canada) or $185 (for other foreign) (in US funds) to:

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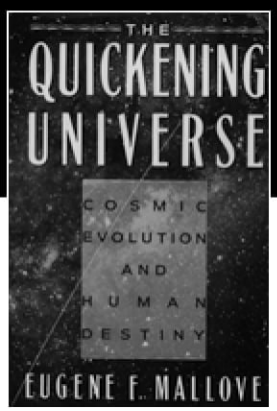
"Dr. Mallove unfolds so many [of the] scientific theories with a vividness that will make them come alive for readers."
—Renee Weber, professor of philosophy, Rutgers University and author of *Dialogues with Scientists and Sages: The Search for Unity*

QUESTION:

WHAT WAS GENE MALLOVE WRITING ABOUT BEFORE COLD FUSION?

ANSWER:

EVERYTHING!



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Infinite Energy Magazine Sponsors 1996 Cold Fusion and New Energy Symposium, January 20th at Cambridge Marriott Hotel

[Editor's Note: Hal Fox of the Fusion Information Center in Salt Lake City (and also an Associate Editor of *Infinite Energy*, wrote this description of our Cold Fusion/New Energy Symposium in Cambridge — adapted from *New Energy News*, February 1996.]

INFINITE ENERGY MEETING

Infinite Energy magazine, sponsored a Cold Fusion and New Energy Symposium at the Cambridge Marriott Hotel on Saturday, January 20, 1996. An estimated 150 persons attended this annual event, which was previously held at MIT. Following is a brief report of the topics covered at this one day symposium. (Subsequent articles in this issue of *Infinite Energy* provide further details.)

Introduction and Overview by Gene Mallove:

The morning began with Eugene F. Mallove, editor of *Infinite Energy*, who gave an introduction and overview of the growing field of cold fusion and new energy. As a part of the presentation, the following video clips were presented: Dr. Tom Passell of the Electric Power Research Institute (EPRI) presented evidence of heavy involvement of nuclear reactions in cold fusion experiments; a Clean Energy Technologies, Inc. video tape about the Patterson Power Cell™ (PPC); and Dennis Cravens' PPC presentation at the SOFE '95 (hot fusion) conference held in Champaign, Illinois in October, 1995.

Jed Rothwell, a contributing editor to *Infinite Energy*, and a co-founder with Gene Mallove of the Cold Fusion Research Advocates, presented a detailed report of the latest public demonstration of the PPC — at the December Power-Gen '95 conference in Anaheim, Califomia. In addition to reporting on the details of the PPC demonstration, Rothwell made some pertinent comments about the business sales strategy for new energy devices. Widespread sales of non-exclusive license rights is highly recommended, together with a marketing strategy thatwould participate in every available type of free advertising, such as through any of the many news media resources.

Eugene Mallove (L), Symposium organizer, introduces Dr. Mitchell Swartz (C) of Jet Technology. Jed Rothwell (R)

Dr. Mitchell R. Swartz presented his report, "Impact of Technologic Advances," particularly those accomplished by Jet Technology (a Massachusetts company founded by Swartz). Swartz presented some excellent information about the progress Jet Technology has been making in the development and detailed understanding of the processes involved in cold fusion. Swartz has several patents pending for important cold fusion technology. He also has several papers being peer-reviewed for publication. Mitchell Swartz must be considered one of the foremost self-funded cold fusion researchers in the world. We look forward to the review of his important publications. Based on his presentation, we expect that his papers will shed further light into the basic mechanism(s) that are responsible for cold fusion phenomena. Jet Technology is among those companies that highly deserve the support of the venture capital community.

Dr. James Patterson, Dr. Hal Puthoff, and Prof. Paul Czysz appeared and presented their views in the December 1995 British video, "It Runs on Water." Patterson talks about his early work (pre-1989) in finding anomalous heat and his approach to the development of the PPC. Hal Puthoff predicts that new energy sources will, indeed, be found.

During lunch at the Symposium the Canadian Broadcasting Corporation's (and BBC's) 1994 program, "Too Close to the Sun" (50 minutes) was played. Of historical interest are the negative comments by Frank Close and also by John Maddox, the editor of *Nature*. The negative assurance of Close and Maddox were in strong contrast to the successful reports of new energy sources presented at this symposium.

James L. Griggs reported on his latest developments of Hydro-Dynamics', latest versions of the Hydrosonic Pump. Commersially being produced and installed to provide lower-cost hot water or steam, the latest pumps provide COP (Coeffident of Perfommance) of 130 to 150 percent. Griggs reported on a recent signing of a joint research effort with NASA at Huntsville which, he said, will include independent efficiency measurement of the operation of the hydrosonk pump.

Hal Fox, together with Gene Mallove, made the first public presentation of the research results of the "Cincinnati Group" of private reserachers. This group of privately-funded researchers

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prefers to remain anonymous for the present. Two important technological discoveries have been made by the Cincinnati Group: the amelioration of radioactive materials (i.e., the reduction of radiactivity incertain elements!) and a new method for heat production at very high temperatures (tover 1,000 degrees C). Hal Fox related the role that he has played for the past two years in advising and encouraging this group in their remarkable new discoveries. The Cincinnati group asked that the following informabon be presented: A patent applicabon was filed on December 23, 1995 relating to a process by which natural radioactivity is greatly reduced by the use of a specially designed reactor. Demonstrations of the ability to reduce radioactivity are being arranged with a government contractor hired to clean up one of the many U.S. government radioactive sites.

Mallove showed a video clip of the Cincinnati Group's discovery of a new means of producing a high-temperature with miniature "fire ball," which could be created with DC current. The video show a device with 70-watt input, creating a high-temperature and melting the surface of a ceramic tile (which melts at about 4,500°F). Another video clip showed the same process being applied to a piece of quartz and the melting of a copper penny. The preliminary measurements (by at least one independent group) indicate that excess heat of about ten times the input electric energy is being produced. The low-budget work of these researchers deserves the immediate attention of the financial community.

Hal Fox also made a short presentation of the "Commerdalizabon of Cold Fusion" in which he cited cold fusion projects (such as the Patterson Power Cell) that are being commercialized. Also presented was a brief description of the Kenneth Shoulders' high-density charge clusters' ability to tap space energy (U.S. Patent 5,018,180). This technology is expected to become a major method of producing low-cost electrical energy. The third important energy development is the mechanical energy produced by the Y. Takahashi super-magnet motor. (See also the presentation by Chris Tinsley.) Fox reported that these three technologies are being or are expected to be commercialized during 1996-97. All three of these technologies, said Hal Fox, deserve substantial funding by the investment community due to their capability to produce very large returns on investment,.

Prof. Keith Johnson, of the Department of Materials Science at MIT, reported in detail on his cold fusion patent, where latent heat of water is one of the heat-produdng sources. Johnson also played a clip from his forthcoming cold fusion techno-thriller movie, "Breaking Symmetry." This movie captures some of the real life drama behind the discovery and controversy of cold fusion and other scientific discoveries.

Christopher P. Tinsley, from Nottingham, UK, (and a contributing editor of *Infinite Energy*) presented informabon about his efforts to investigate the over-unity heat-producing capability of the Potapov water vortex tube. He showed pictures of dozens of these devices being produced in Moldova, which he visited last year with Dr. Peter Glück of Romania. All U.S. tests of this interesting device failed to show over-unity heat production, but Tinsley remains open to the prospect that over-unity conditions can be achieved with these cavitation devices. In addition, Tinsley showed slides of the Sciex Magnet-Powered Scooter. Sciex, Ltd. is the U.K. company that plans to build the "Y.T." magnets invented by Y. Takahashi. As previously reported in this newsletter, the super magnet has been used as the central element in a super motor that has a reported efficiency of over 100 percent. Tinsley showed shots of the motor installed in a motor scooter, which he test rode in London.

An 8-minute video film: "Dream Energy: Magnetic Motor Development," made by Japan's Fuji Television in 1993, was shown to the audience.

Concluding the all-day Symposium, Dr. Paul A. LaViolette made a presentation on "Loopholes in the First Law - Cosmic Evidence?" (See his article in this issue: "Brown Dwarf Discovery Confirms Theory of Spontaneous Energy Generation." For further work of Paul LaViolette, the reader may want to obtain *Beyond the Big Bang: Ancient Myth and the Science of Continuous Creation*, a 1995 book by LaViolette.

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Chris Tinsley: Physics or Fizzix?

Hal Fox, cold fusion pioneer

Hosts: **Jed Rothwell, Gene Mallove, Chris Tinsley**

Dr. Mitch Swartz of JET Technology explains his excess heat experiments.

MIT Professor Keith Johnson explains his cold fusion theory and his movie to be: *Breaking Symmetry*.

The *Spotlight Video* TV Crew Who Captured it All!

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CETI's 1-Kilowatt Cold Fusion Device Demonstration

by Jed Rothwell

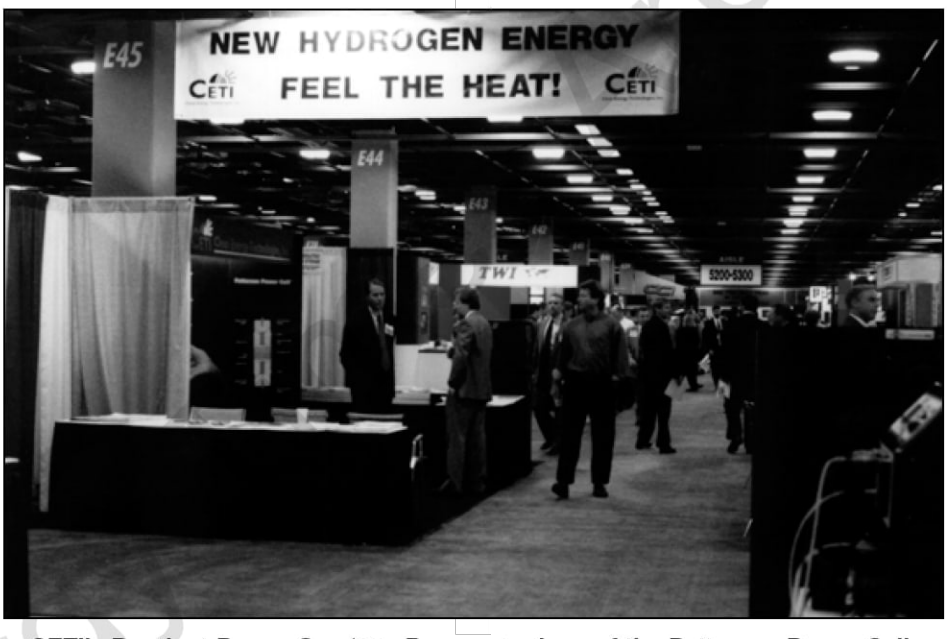
Editor's Note: This is Jed Rothwell's talk at the Infinite Energy Symposium on January 20, 1996 at the Cambridge Marriott Hotel.

I am here to talk about cold fusion devices manufactured by CETI – Clean Energy Technologies, Inc., of Dallas, Texas. I have no affiliation with CETI. My report is based on my observations of two demonstrations, and discussions with people who have independently replicated the device. Gene Mallove and I asked CETI to come here today and give a presentation, but they declined. That's good news for you, because I will tell you a lot more than they would have! I will talk about the three demonstrations, show you a close-up look at the beads, and describe CETI's business plan and their continuing public relations fiasco. [Slide 1 – *Editor's note: "Slides" indicated here for flow, not printed in this magazine.*]]

The CETI devices were invented and patented by Jim Patterson. The cathode is composed of thousands of 1 mm beads covered with multiple layers of electrolytically deposited thin film nickel and palladium. I will not go into the details because the handout includes CETI's address, their brochure, patent numbers and so on.

CETI cells were demonstrated at three conferences last year, in flow calorimeters. [Slide 2] In April, at the Fifth International Conference on Cold Fusion, in Monte Carlo, Dennis Cravens demonstrated a cell running at 2.5 watts. In October, at the hot fusion SOFE conference George Miley's group showed a cell running at 4.8 watts, and most recently in December Cravens demonstrated a much larger cell that ran between 500 and 1,300 watts. Excess power goes up dramatically, and the ratio of input to output goes from 6 to 80 to 4,000. The third test, at the Power-Gen conference, was dramatically better but that is partly because this is a bigger cell, scaled up from 1 to 40 ml of beads. It is also because the reaction is stronger at higher temperatures.

The cells have been independently tested in laboratory settings, not just conferences, at the University of Illinois, by Quinton Bowles at the University of Missouri, and at least one major corporation [Editor's Note: This is Motorola!]. Miley saw excess heat with beads given to him by CETI. His group also fabricated beads from scratch, and saw excess heat from them, too. Miley use vapor sputtering, rather than electrolytic deposition. Before he became involved with Patterson, Miley was working with multi-layer palladium thin film cathodes. He published a paper about that in 1994. Bowles is doing high temperature, pressurized calorimetry.



CETI's Booth at Power-Gen '95. Demonstrations of the Patterson Power Cell unit were in the reserved hotel room. ***(All Power-Gen photos, courtesy A. Kawasaki)***

The calorimetry and some of the cell design in these demonstrations was done by Dennis Cravens. He is an independent scientist who lives in Cloudcroft, New Mexico. At the Fourth International Conference, Martin Fleischmann nominated Cravens for best paper, and Martin said to me, "Cravens is a genius." I said I know, that's what I have been saying for years. He is a genius in the American tradition: a hands-on, practical, Apollo 13 engineer type. He uses rough and ready methods to achieve large, easily detected results. He hates computers. He prefers old fashioned non-electronic instruments, like mercury thermometers. That rough and ready approach is usually a strength, but at Power-Gen it was a weakness.

Let me take a moment to describe what a flow calorimeter is. Flow calorimeters were invented in the early 1900s. They work like a coffee makers. [Photo 1, of ICCF5 calorimeter]. Cold water enters an insulated cell, and it comes out hot. It returns to the reservoir where it cools down again. You keep the flow steady and you measure how much water goes through every minute. The Delta T temperature (outlet minus inlet) in degrees centigrade multiplied by the mass flow equals calories; calories

times 4 equals joules; joules per second equals watts, which you compare to the electric power consumed by the cell. This number 4 is the specific heat of water, 4.2, reduced a little because the cooling fluid is 1.0 molar lithium sulfate electrolyte. The electrolyte from the cell is circulated as the coolant with this configuration. Dennis Cravens carefully tested the electrolyte during extensive calibrations with joule heaters and null electrolysis, and he found the specific heat was never less than 95% of that of pure water.

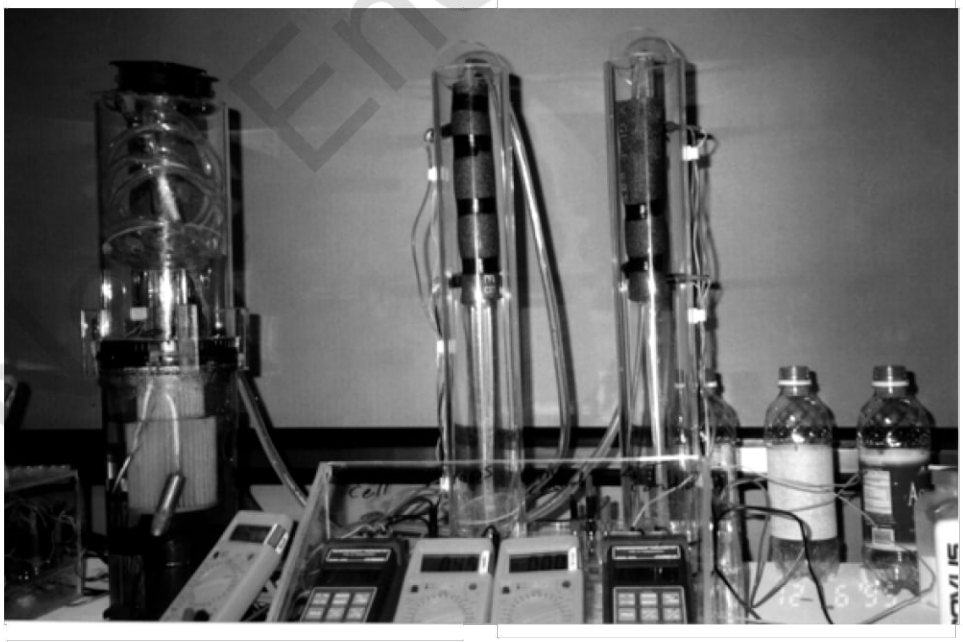
A flow calorimeter works on first principles. It does not depend upon a calibration curve the way a static calorimeter does. You can walk into the room, see the demo for the first time, and do the arithmetic yourself to confirm the excess heat. You do not need to be present the day before to observe a calibration run.

The Fifth International Conference calorimeter was a quality job. Cravens did a superb experiment back in his lab, and then he brought a simplified version of the apparatus to the conference. Even this traveling demo version was a better experiment than many of the ones described during the conference. Imagine setting up these precision instruments, pumps, and whatnot in a hotel room the night before a conference!

The SOFE calorimeter was put together by George Miley's group at the University of Illinois. I did not see it, but I gather it was first rate. (As you would expect.)

The third demonstration at Power-Gen '95 was performed by Cravens. The results were dramatic but unfortunately the calorimeter was not to his usual standards. It was sloppy and unprofessional. Here it is. [See photos] This has a much larger pump, a Magnum 220 aquarium pump, to accommodate the larger heat output. I have several gripes about this setup. It has a CF cell and a control electrolysis cell with a dummy cathode. This is much too complicated. A member of the audience cannot keep track of two cells simultaneously during a demonstration, watching all these meters. Furthermore, on the first day the control cell got plugged up. It had to be removed and replaced with a joule heater. Most unfortunately, as you see it does not have a flowmeter. This was a nuisance. We had to depend upon the graduated cylinder and stopwatch. I will have more to say about this later.

CETI's Patterson Power Cell demonstration showing live and control cells in plastic safety shields (actual cells hidden within insulating foam). Heat exchanger column (to the left) with aquarium pump and fluid reservoir below. Muffin fan tops the heat exchanger tower, allowing witnesses to literally "feel the heat."



Let me just say two things about the quality issue. I raised it and I want to clarify it. I was disappointed because I have come to expect superlative work from Dennis Cravens, and this was merely adequate. *Let me make this perfectly clear: even with this setup and its attendant problems, I have no doubt that the massive excess heat I observed was real.* The Power-Gen demonstrations were witnessed by George Miley, Hal Fox, Tom Passell of EPRI and other big guns in the cold fusion business. When I spoke with them, none expressed any doubts about the results. They are tough, outspoken senior people. A year ago, when Passel saw the calorimeters constructed by Patterson, he did not hesitate to point out the faults, and he said he did not believe the results indicated excess heat. Miley commented that it is a real shame they did not use better instruments, but he expressed no doubt about the results.

The other observers and I believe in this experiment because we made darn sure it was real. We did not take CETI's word for it, we checked. [Slide 3] Flow calorimeters are simple but not foolproof. They have only three parameters: input power, flow rate, Delta T temperature. If you get all three right with reasonable error margins, you can be sure there is excess heat. Here

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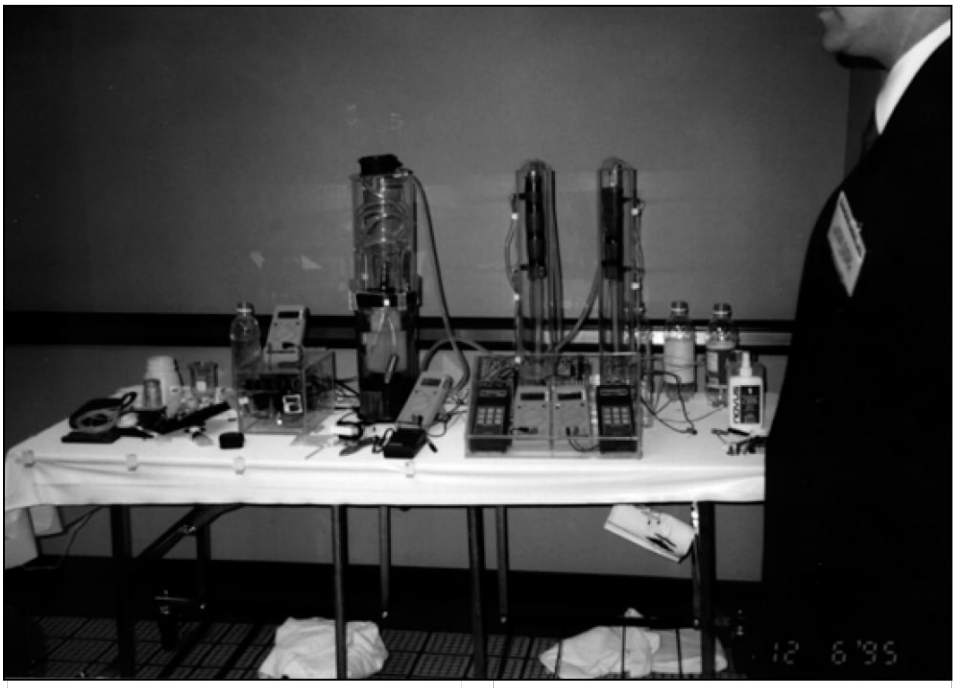


Full view of Patterson Power Cell apparatus and meters, in hotel room where demonstrations took place.

is what we did:

Input power

Dennis measures electrolysis power with Metex M 3800 series multimeters. At Power-Gen he also measured total AC going into all components including the power supplies, pump and fan. It was 85 watts, much less than the excess.

The power supply for the cell is a Radio Shack Universal AC Adapters, with five voltage settings from 3 to 9 volts. It is a small, old fashioned transformer, rated 600 milliamps. It is physically impossible to get 50 or 500 watts out of one of these.

Flow

As I said, Dennis botched this one. A week before the conference he decided the cell was running too hot so he increased the flow rate to 1 liter per minute. Unfortunately his flowmeter topped out at around 600 ml and he did not get a replacement. We had to depend on the manual measurements. This method is annoying. It is imprecise. Accurate, but imprecise. On the other hand, Galileo measured flow this way. It works. Even when a good flowmeter is installed, I recommend a reality check with a stopwatch and cylinder, because that is the most fundamental method. The problem with relying on this method is that if the flow gets blocked, you might not notice it until you measure the flow again. That is what happened with the control cell on the first day. It did not happen with the active cell. We know the flow was steady for three reasons:

1. We tested it repeatedly, taking 250 ml samples over 15 second intervals. We found no measurable variation.

2. You could watch the water and electrolysis bubbles move through the pipes rapidly.

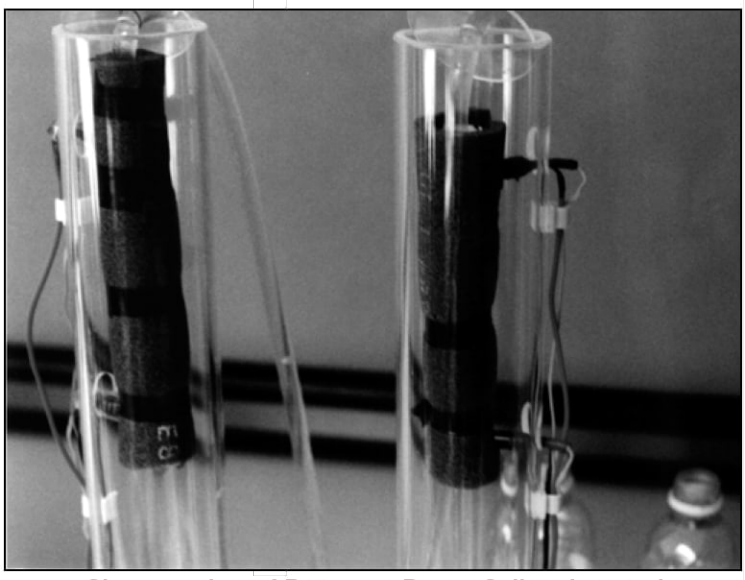
3. To account for the 8 to 17 °C Delta T the pipes would have to be stopped up almost completely, allowing no more than a few drops through every minute. In that case, when we dumped out 250 ml samples, cold water would have covered the outlet thermocouples, the Delta T would have dropped to zero immediately, and it would have taken 10 or 20 minutes to recover. That did not happen.

Temperature

With any calorimeter temperature is the most difficult parameter. You get troubles with improper grounding of thermocouples, crosstalk, instrument drift, weak batteries. Mixing and proper positioning of the thermocouples is critical: you get temperature gradients between streamlines, the "wicking" effects. I circumvented all potential problems by the most direct means I could think of. When I drew 250 ml samples of water to test the flow, I stirred them up and measured the temperature with two thermistors and a mercury thermometer. I found the thermocouples were right on the mark. The Delta T really was 8 or 15°C. Let me add that Dennis did a great job on the temperature measurements. He ensuring proper mixing with Omega brand plastic in-line mixers, which were recommended to him by SRI. He used some clever techniques mounting the thermocouples.

The reservoir fluid was surprisingly cool. It was only about 35°C with 500 watts. Intuitively, it seems it should have been hotter. Some people did back-of-the-envelope estimates and they say the cooling loop above the reservoir should not have had enough capacity to keep the reservoir temperature so low. The cooling loop contains about two and half meters of coiled Tygon R3603 tubing. That fan blew a steady stream of palpably warm air. I did not measure the temperature of the air, but someone computed that with a fan of that capacity if the air was 20 °C hotter than ambient it would remove all 500 watts. The reservoir top has a hole to let electrolysis gas and probably a lot of evaporation. Cravens reported that during calibration runs with the pump running alone the reservoir temperature does not rise significantly. Since the input is the pump plus one-tenth watt, and the temperature went up 15°C, there must be a massive source of excess heat.

Let us have a closer look at the patented cathode material. As I said, the cathode is made up of thousands of small beads or "microspheres." Here is schematic of one. [Photo of brochure] It has a styrene core, copper flashing, and then thin film layers of



Close-up view of Patterson Power Cell and control

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Close-up view of heat exchanger column and aquarium pump-electrolyte reservoir.

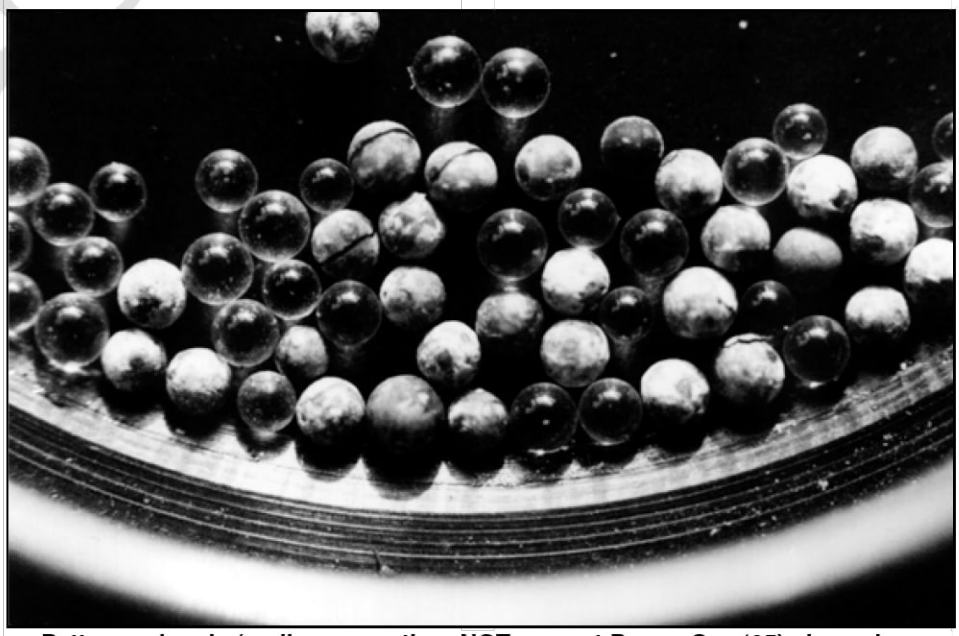
nickel, palladium, and nickel. The role of the palladium is not clear. Ed Storms had some interesting ideas about that. Now this picture shows a perfectly round sphere with splendidly uniform thin film layers. That's the ideal. The reality looks like this. [See photo to right.] This is a photograph of some used beads. This photograph, by the way, is highly unauthorized. I didn't take it. It just fell through the transom and landed on my desk. Ignore these clear beads. They are unrelated. Looking at the cathode beads you see they are not perfectly round and not uniform in size. They are irregular, and so are the unused, new ones I have seen. It is apparent even to the naked eye. There is a lot of damage from extended use. I believe these cracks are caused by repeated thermal expansion and contraction. This one has green spots, which I think may be the copper flashing showing through. The vapor sputtering technique that Miley has developed produces much more regular beads with evenly deposited film layers. Miley thinks this will lead to enhanced performance. The first generation beads he fabricated did not work as well at high power, but they worked better at very low power.

This photograph illustrates the Achilles heel of the CETI cathode, and of all electrochemical cold fusion cathodes. Wear and tear, the enormous pressure from hydrogen loading, and contamination limit the lifetime of the materials. The CETI cathodes hold up much better than most other kinds. A few years ago, Miley's thin film cathodes self-destructed from the heat in a few hours. Ed Storms describes the cracking, swelling and damage that prevent many palladium cathodes from working. The secret to cold fusion is finding good materials. The beads shown here are first generation devices used on and off over several months I think. Patterson has subsequently found ways to reduce the thermal expansion, and to make the thin films stick on tighter. He has substantially increased the life of the materials. I think they now last long enough to be used in practical devices. A cold fusion cell that lasts a year would be economical. If it included thin film palladium, the metal could be recycled.

The material in these beads that gives the most trouble is the styrene core. At temperatures above 200°C the beads have to be kept at high pressure or the styrene sublimes. If I was CETI, I would be looking for replacement core material. It has to be non-conducting and you have to be able to attach thin films to it. Many people have suggested that a ceramic might work well.

Now let me discuss some aspects of CETI's business strategy and the background of this demonstration. I am deeply unhappy with their business strategy. I think their experiments are superb, I think their willingness to demonstrate the devices in public is laudable, I think their invention is one of the most promising and practical implementations of cold fusion energy. CETI and I agree about many things, but when it comes to business strategy, we are worlds apart. I spoke with them yesterday and we remain at odds.

You will have noticed that CETI did a strange thing. After doing two superb demonstrations, they showed up at the preeminent power industry trade show with a merely adequate experiment. It was good enough as an experiment, but as a trade show exhibit it was a fiasco. They should have had a big red digital display of the temperature, a computer monitoring everything showing a graph of excess power, and a big sign: "1 WATT IN, 1000 WATTS OUT!" On the second day they took the demonstration out of the trade show hall and hid it in a hotel room. They made no attempt to convince people that the thing was real. If they had brought a properly designed trade show display, they would have had 14,000 potential customers eating out of their hand. And they had a lackadaisical attitude. Cravens called the demonstration "fun and games" saying his real experiment was back at the lab.



Patterson beads (earlier generation, NOT ones at Power-Gen '95) show clear signs of cracking damage to metal coatings after prolonged use. Some beads have *no* coating. *(Photo Source: Anonymous)*

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There is more to this sad tale. I helped arrange for their cell to be tested in one of the finest laboratories in the country. First the trip was arranged, then CETI canceled. Then the trip was back on again and my friends at the lab went out and bought expensive new equipment for the tests. And then at the last minute CETI called them and canceled again! That's not all I did. At CETI's request I contacted some top science journalists about this story. At CETI's request I suggested they come to the conference. When one of them offered to send in a film crew, CETI got cold feet, changed their tune, and uninvited him. Their strategy appears to be based on the coitus interruptus school of public relations. This is crazy behavior. It looks suspicious.

So what is going on here? Well, when a smart guy like Patterson or Cravens does a stupid thing like this, there is always a reason: it's either love or politics. In this case, it's politics. CETI is courting a large U.S. corporation. They want to conclude a deal, and the big corporation does not want CETI talking to other people. The big corporation wants them to keep this technology secret. CETI and the corporation want to work together quietly, out of the limelight, off in the corner, developing better beads. They want to patent more peripheral technology, like the bead bed configuration. CETI told me they are working with their Strategic Development Corporate Partners in a carefully planned R&D program. They want to develop prototype consumer products in six months to a year. Then, I suppose, they hope to spring this marvelous fait accompli on the world, wrapped up in pink ribbon. That's the plan.

This big corporation put pressure on CETI, asking them to pull out of the trade show. CETI went ahead but at the same time they deliberately tried to avoid attracting attention. They told me they did not want to attract hoards of new customers. CETI says they want to, quote, "keep this R&D project manageable." They want only four or five corporations and universities to participate in the research at this stage. They say they want to maintain control over the development progress. They also tell me that they are pleased to see that cold fusion continues to languish in obscurity because that gives them more opportunities to develop the technology without competition. They see it as a chance to stake out a larger share of the future market.

Scores of people would pay good money for those beads today. The people in this audience would, hundreds of people at that trade show would have. CETI could manufacture a liter of beads for $10 and sell it for $10,000. They could sell as many as they wanted. For months, I have been urging them to sell the beads. Sell them to anyone who wants. I say: don't worry about people stealing the ideas because the patent applications are filed. Get a positive cash flow. Line up paying customers who are wildly enthusiastic about your product. By golly, if I was in charge of CETI, I would have come to that trade show with hundreds of cells, ready to hand out.

Part of the Power-Gen '95 "Cold Fusion Gang": (L to R) Jim Reding (CEO of CETI), Dr. James Patterson, inventor of the Patterson Power Cell (and Jim Reding's grandfather); Jed Rothwell, *IE* Contributing Editor, Dr. Thomas Passell, head of EPRI's formerly robust, now moribund cold fusion program. Japan now funds SRI.

A business starts out one sale at a time, one customer at a time. That's how Ford sold his first cars, and that's how Bill Gates sold his first software. Later on, after Gates developed credibility and a large customer base first, then he began cutting deals with IBM. Big companies seldom buy into new, radical, unproven technology.

These beads are an ideal product. The potential market for them is gigantic. They can be manufactured out for very little money, and sold at a premium. It's an ideal opportunity, like Intel selling microprocessors. Ideal business opportunities like this never last long. Someone else will come along and sell something as good as the beads, and that will be the end of CETI's chances. A better product might come along any day now! We know several scientists, like Piantelli and possibly Jim Griggs who are waiting in the wings with devices that might soon better than CETI's beads. If CETI started selling now, today, they could become established as market leaders. They could make a lot of money. They could plow the profits back into their technology, keep improving it, and stay in the running. They might stay ahead of the competition. Even if they don't survive they can make a lot of money for a while. Early in the microcomputer revolution, Zilog was the leading microprocessor manufacturer, and Digital Research outsold Microsoft. Those companies are long dead, but for a few hectic years they made a lot of money and if the owners were smart they got to keep most of it.

CETI told me yesterday that they are only willing to deal with companies that are willing to invest $20 to $30 million in production. I do not understand why. A smaller company could easily design a product and bootstrap up production. Companies like Hewlett Packard, Apple, Ford and Microsoft started out on a shoestring.

If you ask me – and nobody is asking me, especially not CETI – they should not worry so much about the competition, they should concentrate on the customers. They should not worry about shaping future market share when their present market share is zero. They should not try to shape, direct, and ride herd on the development of this technology. Nobody can do that. Nobody can predict what a new product will be good for. When lasers were invented people thought they would be good for cutting meat; they never dreamed we would check out groceries with them, or look up things in CD-ROM encyclopedias. When they invented microprocessors,

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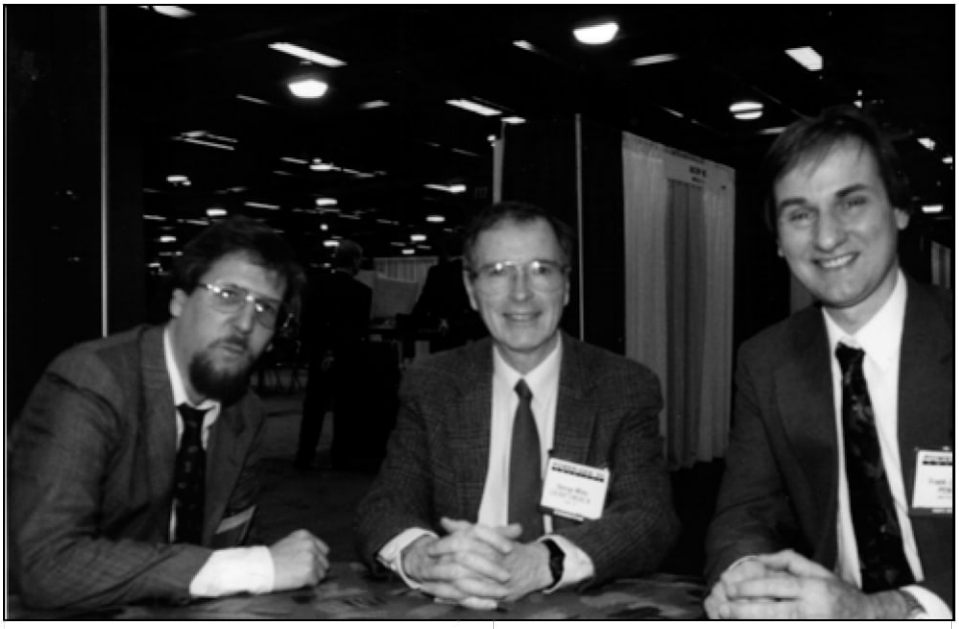

A station break at Power-Gen '95: Jed Rothwell with Prof. George Miley (University of Illinois, Nuclear Engineering) and engineer Frank Znidarsic of Pennsylvania Electric Company (GPU).

Zilog, Intel and Motorola had no idea what they would be good for, or how many they could sell. They did not pick five "strategic corporate partners," go off into a corner and spend years secretly developing microcomputers. No, they simply announced product availability in the trade magazines and started selling to any company. They even sold them to individual computer hobbyists in the early days. They did not try to limit the number of customers, they did not try to tell the customers what they should do with the product, and they did not slow down sales and limit development in order to take charge of the process and win a larger future market share.

Maybe I am wrong about this. Maybe this product is not like Ford's automobiles, Bill Gates's Windows, Mac-Donald's hamburgers, Mrs. Field's cookies, or Pete Peterson's WordPerfect. Those products succeeded with a simple, direct, old fashioned marketing approach, which Peterson described. [Slide 4] Perhaps cold fusion calls for a much more complicated, convoluted approach. My guess is that the laws of marketing apply to all products, and that any strategy more complicated that necessary is a mistake. Perhaps CETI will succeed in a big way, and they will go down in history and change the rules. If so, I will say that they succeeded in spite of their strategy, not because of it. The product is so good that a lousy strategy might work.

What leads CETI and many other R&D companies to act this way? It is what I call the "inventor's disease," or the Own Worst Enemy syndrome. Some of the finest scientists and inventors in history have suffered from this disease, including Newton, Galileo, the Wright Brothers and Pons and Fleischmann. I think that CETI has a mild case. Until recently they have shown good business judgment. I am confident that they will soon be back on the right track. They told me their increased secrecy is temporary policy, and they will be back to doing demonstrations, showing products and sharing information freely again in six months to a year. I culled this list of symptoms from many different companies in cold fusion, computers and other cutting edge technology. I want to emphasize that CETI does not suffer from all of these faults, and for that matter, even the best ventures are not completely free of them, nor can I myself afford to throw the first stone [Slide 5]:

THE SYMPTOMS OF THE INVENTOR'S DISEASE, A.K.A. "OWN WORST ENEMY" SYNDROME

• **Hubris.**

• **Grandiose schemes** to take over unrealistically large future market share when your present market share is zero.

• **Orientation to the future to such an extent that present concerns are ignored,** present needs unmet. Paralysis of analysis, and the never ending refinement cycle. Some inventors never get the product out the door because they are forever tinkering with it, improving it, and "the next version will be so much better."

• **Hiding results for long periods for no rational reason.** Delays introducing products for no reason. Inordinate concern with competition and with intellectual property, often mixed with a curious and unjustified contempt for the competition's products. When you run a race you must watch where you are going and look ahead to the goal. You don't try to run while looking over your shoulder to see who is gaining on you. The goal is to sell products and satisfy customer needs.

• **Trying to do it all yourself.** Not sharing information, not hiring enough people. CETI can afford to hire someone to assist Cravens.

• **Obsession with status.** A strong desire for approval from academic societies. Fantasies about the Nobel Prize. A business plan that depends upon complex contracts giving the inventor the inside track with large corporations, rather than selling to the customers who want the product today. I cannot understand why people think a dollar from General Electric is better than a dollar from you or me.

• **A control fetish.** A desire to have your cake and eat it too. Scientists want to control the way their customers use the product, which is none of their business. Ford does not tell you how to drive, Intel does not care what you compute or how many computer makers use their product.

• Here is a problem CETI does not have: an **obsession with a theory.** Customers want machines, not theories.

• **Finally, inexperience with business.** Scientists often try to build businesses the way they do experiments. They think business is a logical, predictable, step by step process. Here is how a scientist thinks you make a lot of money: You assemble a convoluted business mechanism held together with complex contracts and oh-so-clever patents. When every part is tested, calibrated, oiled, and smoothly running, you press a button and a giant bundle of money falls out: a million dollars. Plunk!

This is how an old fashioned businessman like me thinks you make money: Build a great product. Sell it for a good price. Build a reputation for honesty and good service. Bingo, the orders roll in and in a few years you make a fortune. It's simple. Anyone could make a fortune with a product as good as CETI's cathodes. CETI may wake up to the opportunity and begin

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selling what they have now, as is. It is good enough! For the life of me, I cannot understand what is holding them back. When they finally do sell, within months they will ignite a world-wide burst of enthusiasm for cold fusion and they will start to make loads of money. It will be the biggest boom in business history. If CETI does not do it, someone else will ignite the revolution

Thank you.

POWER-GEN '95
TEST 1 DETAIL

INPUT
AC: 120 V * 0.7 A = 84 W
Electrolysis: 8 V * 0.18 A = 1.4 W

OUTPUT
Flow rate 1200 ml/minute
(300 ml/15 seconds)
Delta T Temperature 16 to 17 deg C
1200 ml * 16 deg C * 4.0 =
76,800 j/min = 1,280 W

HOW WE VERIFIED THE CALORIMETRY

INPUT POWER
Metex M 3800 series multimeters. Both electrolysis and AC were much less than excess power. Electrolysis power supply was Radio Shack Universal AC Adapters, maximum rated output: 5.5 watts.

FLOW
Stopwatch and graduated cylinder. 250 ml samples taken over 15 second intervals, repeatedly. Hey, it worked for Galileo.

TEMPERATURE
Carefully placed, redundant thermocouples, mixing ensured with Omega in-line mixers. Temperatures verified independently with 250 ml samples using two thermistors and a mercury thermometer. Delta T temperatures ranged from 6 to 17, which is extremely large for a flow calorimeter.

Sample results from four CETI demonstrations

Location	Date	Volts	Amps	Watts In	Flow	Delta T	Watts Out	Ratio
ICCF5	Apr. 10	3.8	0.12	0.45	10.11 ml	3.6	2.5	1:6
SOFE '95	Oct. 1	3.0	0.02	0.06	14.28 ml	4 – 5	4.8	1:79
PowerGen	Dec. 5	8.0	0.18	1.4	1300 ml	16 – 17	1280	1:914
PowerGen	Dec. 6	3.9	0.02	0.1	1000 ml	6.7	447	1:4470

"Do you try whenever possible to choose the simple rather than the complex solution? Business is a fairly simple activity. You identify a need, figure out how to fill it, manufacture your solution, and find the best way to sell your product at a profit. You then support your customers with reliable service consistent with the price you charge, make sure you collect your money, and pay your taxes on time. After that, you listen to your customers, and based on what they tell you and whatever else you figure out, you improve your product as fast as you can to stay ahead of your competition. All the other things, like strategic alliances, weird pricing and promotional schemes, and trying to create needs when they do not exist, introduce complexities that never help in the long run. I never found an occasion when the complex solution was better than the simple one."

– W.E. Pete Peterson,
Former Executive V.P.,
WordPerfect Corporation

Latest Patterson Patent Granted in U.S. #5,494,559

Patent Number: 5,494,559
Date of Patent: Feb. 27, 1996
SYSTEM FOR ELECTROLYSIS

Inventor: James A. Patterson, 2074 20th St., Sarasota, Fla. 34234
Appl. No. 488,609
Filed: Jun. 8, 1995

References Cited

U.S. PATENT DOCUMENT S

3,632,496	1/1972	Patterson	204/249
3,888,756	6/1975	Teshima et al.	204/275
4,269,689	5/1981	Agladze	204/268
4,316,786	2/1982	Yu et al	204/223
4,913,779	4/1990	Lacoste	204/1.11
4,943,355	7/1990	Patterson	205/51
5,036,031	7/1991	Patterson	502/10
5,318,675	6/1994	Patterson	204/86
5,372,688	12/1994	Patterson	204/222

Primary Examiner—Donald R. Valentine
Attorney, Agent, or Firm—Charles J. Prescott

ABSTRACT

An electrolytic cell and system for electrolysizing and/or heating a liquid electrolyte containing water having a con-ductive salt in solution flowing through the cell. The ele-trolytic cell includes a non-conductive housing having an inlet and an outlet and spaced apart first and second con-ductive foraminous grids connected within the housing. A plurality of cross linked polymer microspheres each having improved conductive exterior multilayers of uniform thickness are positioned within the housing in electrical contact with the first grid adjacent the inlet. The conductive micro-spheres are plated first with a metal cation which will reduce with hydrazine to form a conductive metal flash coating. The microspheres are then plated with a uniform layer of nickel, followed by plated layer of metallic hydride which is readily combineable with hydrogen or an isotope of hydrogen, then a uniform metallic support plating having a high hydrogen diflusion rate and a low hydride formation ratio. An electric power source in the system is operably connected across the first and second grids whereby electrical current flows between the grids within the liquid electrolyte.

52 Claims, 2 Drawing Sheets

SYSTEM FOR ELECTROLYSIS

BACKGROUND OF THE INVENTION

1. Scope of Invention

This relates to electrolytic cells, and more particularly to an improved electrolytic cell for electrolysis of water and the production of heat.

2. Prior Art

The present invention utilizes and improves upon microspheres formed of non-metallic beads which are plated with a uniformly thick coating of palladium. These palladium coated microspheres are taught in my previous U.S. Pat. Nos. 4,943,355 and 5,036,031. In these above-recited previous patents, cross linked polymer microspheres having a plating of palladium are taught to exhibit improvements in the absorption of hydrogen and isotopes of hydrogen. Utilizing these catalytic microspheres led to my later U.S. Pat. Nos. 5,318,675('675) and 5,372,688('688) (incorporated herein by reference) which teach an electrolytic cell and system for, inter alia, producing heat

The use of a palladium sheet to form one electrode within an electrolytic cell to produce excess heat, the electrolytic cell

Continued on page 30

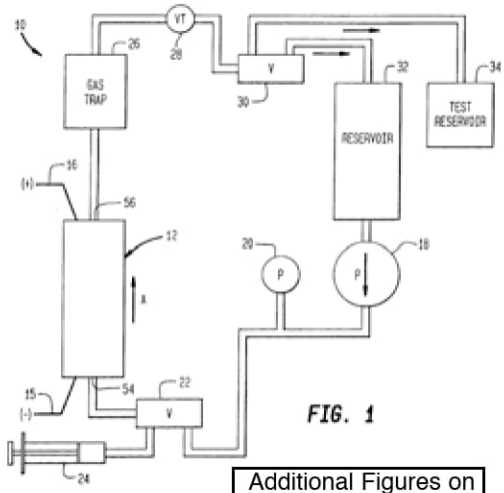

FIG. 1

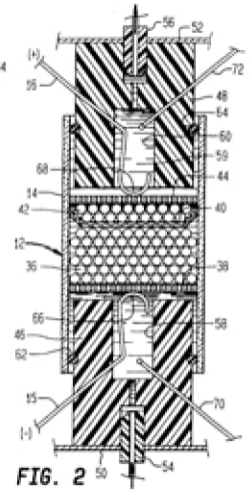

FIG. 2

Additional Figures on Page 55.

being a Pons-Fleischmann-type is taught by Edmund Storms.

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Notes on the talk by James Griggs of Hydro Dynamics, Inc. at the Cold Fusion & New Energy Symposium, January 20, 1996

by Jed Rothwell

At the Cold Fusion & New Energy Symposium on January 20, 1996, Jim Griggs of Hydro Dynamics, Inc., Rome Georgia, gave a presentation and showed a short video. This report is based on his talk and on some later follow-up questions.

Griggs began by describing how he invented the Hydrosonic Pump. When he first built the pump he did not believe the experimental results showing that it was producing more energy out than in. He says he put it aside for several months and came back to it later. Griggs claims he invented this independently, although Schaefer patented a similar machine years earlier, as referenced in the Griggs patent. See U.S. Patents 5,188,090 (Griggs) and 3,791,349 (Schaefer).

He claimed that when I (Jed Rothwell) first came to visit Hydro Dynamics, I brought a postage scale to weigh water and a kitchen thermometer, because I was unaware of the large scale size of the machine. For the record I would like to say that is incorrect. He told me before I came how big the machine was, but it was still a shock. Hearing about a 30-horsepower motor driven machine is one thing, standing next to one in operation is quite another. I did bring a kitchen thermometer but that will work with any machine, of any size. It is a good thing I brought it too, because as I wrote in my first report, I found significant errors in the thermocouple configuration he was using at that time. These errors invalidated his results. He adjusted the configuration, resetting the controller DIP switches and when I returned a week later, another test showed positive results.

Griggs complained about the costs of R&D imposed on him by the demands of scientists. Quote:

"Over the course of time, one thing I'll tell you about being around Jed though, his business ideas - what he thinks about business - from a research standpoint— he'll spend some money for you! By having all the recommendations that Gene Mallove and Jed and all the other scientists have made, in our method of testing, we've spent about $250,000 worth of testing over the last two years. Buying equipment, doing tests, building new rotors. . ."

His prototypes are one-of-a-kind devices. Nobody in industry routinely manufactures items like this, so they must be fabricated by special order, which makes the cost high. He uses trial and error methods. He drills specific holes at specific angles and if it works, he "makes a note of it and tries to build on that." If it does not work, it becomes scrap.

James Griggs of HydroDynamics, Inc. at the *Infinite Energy* Symposium on January 20, 1996

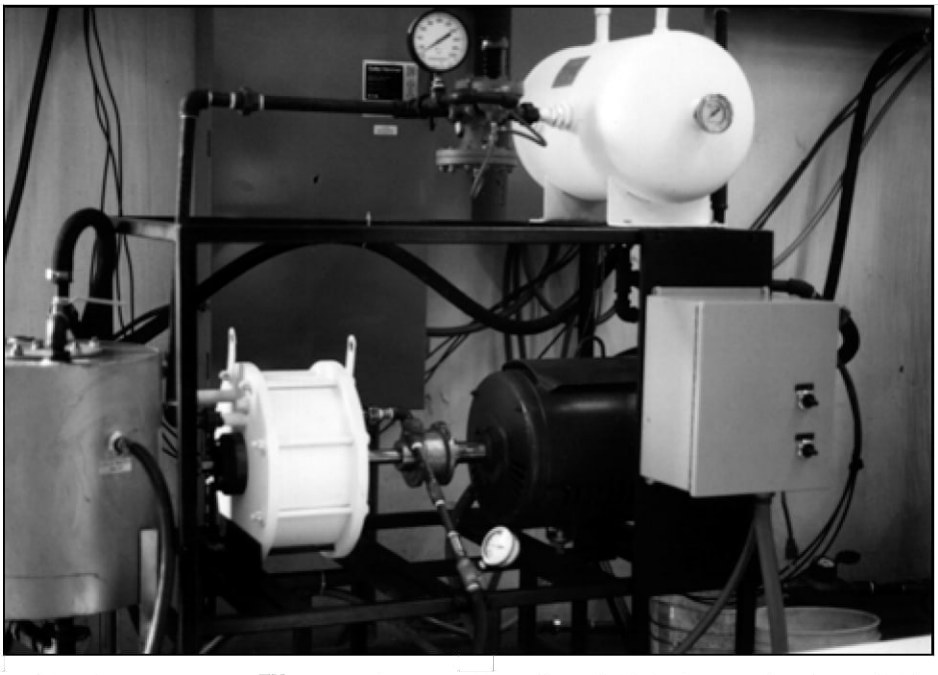
Griggs described the experimental technique, instruments and precautions, which are impressive indeed. His instruments include J-type thermocouples, a dynamometer, two independent ac power meters, and three different flowmeters. He uses 6 thermocouples to measure inlet temperature and 6 to measure outlet temperature. The dynamometer is an Eaton rotary transformer torque sensor model 1805-5K. The flowmeter readings are confirmed by collect the water in a 55-gallon steel drum and weighing it. In a hot water test the water is directed into the drum. In a steam test, the drum is filled with tap water before the test run and the steam is bubbled through and condensed in it. The thermocouples are calibrated by placing them in with boiling water and in an ice bath before experiments. During the course of the experiment, the six inlet probes are swapped with the six outlet probes. The dynamometer was calibrated before and after the test. The length of the arm extension was measured with great precision, and the weight was verified on an ultra precise scale at Georgia Tech. The quality of the steam is verified with a sample cooler which condenses the steam. These extensive cross-checks and redundant instruments makes this some of the most impressive calorimetry I have seen anywhere. In terms of care and redundant instruments, this rivals the best laboratories like SRI and IMRA (Toyota). The machine is gigantic compared to the devices tested with ultra-high precision instruments at SRI, so the calorimetry cannot be as precise, but given careful test procedures, the redundant instruments, and the high signal to noise ratio Griggs has achieved, I think his results are as convincing as any. Although the Griggs machine has not been independently manufactured from scratch and verified in a well-documented example, there are reports that Shaeffer achieved similar results (see *IE* #3, pp 30-32), and the Griggs device has been independently tested and confirmed.

Griggs devoted most of his talk to the commercial aspects his company's work. He began by describing the dilemma he faces when selling the pumps:

"Gene and Jed talk about 'hoping to see cold fusion commercialized in the near future.' Well, we have been in the process for the last number of years of trying to sell pumps. One of the things you run into, especially you engineering types, is, if you produced data that shows you are getting more energy out than in, and you are trying to sell these systems to a manufacturing facility, they think you're nuts. You lose all credibility right off the bat. So, we have never tried to sell a system from the standpoint that it put out more energy than in."

Later in the talk, he clarified his position, in a sensible, realistic manner:

"I want to make a statement. I don't



A hydrosonic pump™ in a testing configuration at HydroDynamics, Inc. Fluid rotation chamber (white), electric motor to immediate right. ***(Photo: E. Mallove)***

know if there is excess energy there or not. It is my personal belief that there is. All the testing that has ever been done by us or any group of scientists or engineers that has been into our lab – into our company – have come up with the same results. Their explanation is always 'there is something wrong with our test procedures.' So we have kind of set that aside. We are devoting about ten percent of our resources to going after that energy phenomenon. We are going after commercialized aspects of using the pump."

Griggs wants to avoid the controversy and concentrate on business. I regard this as the best thing to do under the circumstances. He cannot hope to persuade major academic scientists to examine the machine and admit that their findings indicate excess heat. They will simply declare that there must be some mistake in the methods or instruments. They will refuse to specify what the error might be. We have seen this response over and over again in the cold fusion debates. There is nothing Griggs can do to change the policies of the American Physical Society, the DoE or the Patent Office, and it would be a fruitless waste of time for him to try. If he tries to change their minds, or if he repeatedly, publicly invites them to test the machine, he will only stir up trouble for himself.

He now has worldwide patent protection, and he is applying for additional patents.

The machine as it now performs cannot compete with conventional gas or oil –fired boiler systems. It is not economically attractive. It competes well against large electrically powered boilers, which use roughly three times more energy than gas-fired boilers. Two-thirds of the thermal energy from the burning coal or oil at an electric generator plant is lost by the time the electricity reaches the water in an electric boiler. In spite of this inefficiency, there is a niche market for large electric boilers in specialized applications, for example in a shopping mall dry cleaner, or on a factory floor where an open flame is prohibited because inflammable chemicals are used.

As he has often said in the past, Griggs says he does not know what the energy source is. He does not know the mechanism, and he refuses to speculate on it because he is not a scientist. He has, however, made important discoveries that should help clarify the mechanism. He has verified that the excess heat is linked to cavitation bubbles that collapse in the fluid. He has built a glass and plastic version of the pump. When the model is run at high speed so that the rotor perimeter speed is the same as the large units, ultrasound and cavitation are observed. He was hoping to bring a film showing the plastic model run, but his patent attorneys asked him not to. The water goes from clear, to milky, to grey to a blue color.

Recent tests have confirmed that the heat transfer takes place in the liquid. The liquid is as hot as or hotter than the metal, so by the Second Law of Thermodynamics we know the heat generating reaction must be occurring in the water. This rules out the kind of mechanism E-Quest Sciences (Palo Alto, CA) describes, in which they load metal samples with adiabatic ultrasound bubble collapse. (See *Infinite Energy* Vol. 1, No. 1). The fact that heat originates in the water has many important technological implications. With conventional systems, a gas fire or electric resistance heaters create a hot surface and the liquid comes in contact with the surface. The temperature of the surface is between 700 and 1500 deg F. With the hydrodynamic pump, the metal surfaces never get any hotter than the liquid medium. This is a big advantage, it means they don't have to use water as the only heating fluid. They can use heating oil as a medium. They do not experience the 'cracking' problems. When you heat up oil to 1500 degrees in a conventional heater, it undergoes chemical changes that degrade it and separate it into different fractions of oil. This self-heating feature is also important because it means the device can heat things like polluted water or used antifreeze, distilling the water and reconcentrating the ethylene glycol. In one test, Griggs distilled potable water from the Chattahoochee river water taken below Atlanta, which is like an open sewer. He has distilled potable fresh water from ocean water. Unlike a conventional boiler, you do not get a scaling, coating or build up of salt because the surfaces are not hotter than the fluid. The process is simpler than reverse osmosis, and the machinery is cheaper and more reliable.

Rotor sizes range from 4 inches to 24 inches in diameter. The Tennessee Valley Authority (TVA) wants what they call "a small prototype unit" which means a machine six feet in diameter, 12 feet long. The TVA hopes to attach these pumps to turbochargers attached to their steam turbines. They expect a 3% increase in efficiency, which would save approximately $1.5 million per year.

They have had meetings with NASA. Eight NASA engineers came to the plant to look at the system. They were 'excited by' the computer printout of the energy balance. Griggs claims he has established a formal two-year R&D contract with NASA at the Marshal Space Flight center in Huntsville, Alabama. He claims to have a Space Act Research Agreement, which calls for a test of the pump efficiency. He showed a viewgraph of the contract and underlined a portion that specifies that "they are going to test it to see what the energy output is." This part of the contract should be executed in about nine months. (Note: in a sane world, this would be done in 9 days, not 9 months.) Hydro Dynamics is delivering three pumps to NASA for testing. The marketing agreement with the TVA also specifies that they will also check the efficiency of the system. In January 1995 Hydro Dynamics delivered a unit to Georgia Tech, which is investigating the cavitation. Georgia

Tech has been hoping to win a Small Business Innovation Grant (SBIR) to investigate the pump. They want to know how Hydro Dynamics has managed to convert cavitation into a useful form of energy, rather than trying to eliminate it. Georgia Tech is also reportedly checking energy efficiency and they have seen "crossover" (as Griggs calls it) where output exceeds input. They have not officially released their report and they did not let Griggs quote it during the symposium, but he hopes he will be able to do so soon. Griggs hopes that by the 1997 *Infinite Energy* CF/New Energy symposium, he will be able to bring in papers, and maybe even bring some live scientists to talk about their evaluations.

After the symposium, I asked Griggs for the name and address of his contacts at NASA and Georgia Tech. He refused to give them to me, so I cannot confirm his claims. I find his refusal disturbing. He indicated that the NASA people do not want publicity, and they do not want swarms of people asking them about their cold fusion research. It does seem likely that they want to avoid the stigma of working in this controversial field, but research contracts of this nature are a matter of public record, and as a Georgia taxpayer I have every right to know about both NASA and Georgia Tech. This kind of silly, counterproductive evasiveness calls into question other aspects of Griggs' presentation. I have not had much time or inclination to pursue the matter via independent channels. The bureaucracy at these organizations make finding the names a day-long or week-long project.

Griggs described the visit by Tom Droege of Fermilab in Batavia, Illinois. One of the first things Tom said was "you are not a scientist" to which Griggs replied "you're not an engineer. I never claimed to be a scientist." Griggs says he was surprised that Droege never made any measurements. He came to verify what they were doing, yet "all he wanted he wanted to look at was our paperwork." Droege "didn't want to see a system running." Droege later explained he was looking for a logbook. Griggs has computer printouts showing excess heat, but Droege refused to examine them. He was only interested in seeing a traditional handwritten laboratory notebook.

They have gradually improved the performance of the pump. In 1994 they were generally 108 to 110% efficient with hot water and usually 130% efficient with steam. (That is the C.O.P.; output is 130% of input.) In more recent work they have achieved constant 40% to 50% steady excess. This is good, but it is not enough to be a significant economic or competitive advantage.

Griggs pointed out that the December 17, 1995 British TV documentary by "Channel 4", *"It Runs on Water,"* showed a pump that had been installed in the fire station for more than two years, and that county government has other systems. The fire station system was verified by the engineers from Georgia Power and Valdosta State University. They used their own instruments on systems installed in the field, and found 130% efficiency. The documentary filmed a test run, but it did not broadcast that footage, which is a shame.

Systems have been installed in dry cleaners and factories. Hydro Dynamics has recently negotiated a sales contract to sell approximately 40 systems in South Africa.

Griggs described an interesting application for the pump when used with windmills. He started by saying that wind power is an example of a promising alternative energy source completely unlike cold fusion or conventional fossil fuel. Windmills have been in use for hundreds of years. But windmills that convert wind power into electricity are only 38% efficient at best. Griggs is negotiating a sales contract to use the pumps with windmills for a brand new application. Windmills will drive pumps to make steam. The steam can in turn be run through a low pressure steam turbine generator. These are about 60% efficient. Thus, they can make electricity using about 60% of the wind energy. Furthermore, they can use water supplies from the ocean or from polluted water supplies, so as a bonus they get pure, potable water from the turbine condensation. Furthermore, the hot condensate can be used for space heating or boiler make-up water, in a co-generation scheme, because the windmill is right at the site where the energy is needed. So even though 40% of the wind energy does not go directly into electricity, it is not all wasted.

When you run the pump to distill polluted water and generate steam, you cannot get 100% distillation, because you have to run through some unboiled water to clean out the brine, salts and other solids left behind when the water boils. The mixture of unboiled water and steam that comes out of the pump goes through a separation tank. The unboiled hot water can be run through a heat exchanger to heat up the incoming make-up water. Even with this inefficiency, they can theoretically use 80% of the windmill energy. If they can improve the pump over unity effect moderately, they can achieve even better windmill efficiency. Griggs pointed out that windmills are an important source of energy in the third world.

The Droege Visit

Tom Droege, of Fermilab, visited Hydro Dynamics twice, ostensibly to find out about the Griggs machine. He posted his findings in a report in the Internet newsgroup sci.physics.fusion, on March 17, 1995, in a report titled "Griggs Visit Report" parts 1 through 5. Droege refused to watch the machine in operation. Griggs later told me he had to practically grab him by the arm and drag him over to the machine, and in any event, Droege took no notes and made no observations of the performance. Droege took no photographs, videos, or observations. He did not bring any power meters or thermometers. When he left, he did not bring home any computer printouts, blueprints, patent copies, sales literature or test equipment spec sheets. I brought back an inch of this sort of reference material after my first visit. Droege did not report any details about the calorimetry like the temperature, volume of water, flow rates, power levels, or the make and model of the instruments. He did not describe the test methodology or mention any specifics about results. He did not report basic details like the dimensions of the machine or the rating of the electric motor. He described a few instruments in vague terms. For example, he described the data acquisition computer as follows:

"It has a 486 CPU [computer] with a simple but effective presentation. The only strange thing was the speed of operation. It took a half minute or so between data points. This reading [sic] only 12 thermocouples the torque meter and a few other things."

I have never seen a scientist describe an instrument in this fashion. "A few other things" indeed! Based on a three minute phone call with an engineer at Hydro Dynamics, I would describe it like this:

The data acquisition computer is a 80486 IBM compatible that polls the 12 thermocouples, one of two flowmeters, and the dynamometer 20,000 times per minute. It can be programmed to display and print average values for these readings periodically, usually once a minute, and it prints a summary at the end of the test. It integrates the values to compute and print BTUs (output thermal energy) and the COP (efficiency, including excess heat). Two Omega brand impeller flowmeters are installed, to measure two ranges of values. The high capacity unit is for water flow tests, the low capacity, high precision flowmeter is for the steam tests.

Elsewhere he makes astonishingly flippant remarks like this one:

"A wild guess is that it was a 50 Hp motor."

The rating for an electric motor of this class is written on large brass plate, prominently displayed. Why would anyone take a wild guess about a thing like that? The motor rating is an important test parameter. If you forget to write it down you can always call them and ask.

Droege speculated that the Hydrosonic Pump might interfere with the thermocouples, causing spurious readings of excess heat. He did not bother checking this hypothesis by comparing the thermocouple reading to the bimetallic thermometers mounted next to them, or by watching the thermocouple readouts for a few minutes after the machine was shut off. If he had taken a few minutes to do that, he would have seen that he is wrong: the machine does not affect thermocouple readings. He proposed other speculative ideas about possible errors. He could have checked for every one of these ideas in ten minutes, but he did not check for any of them, because he wanted to leave open questions and nagging doubts in the minds of his readers.

Droege concluded: "I judge the data acquisition system to be adequate for the task at hand. . . .In general all the instrumentation is adequate to perform good experiments if they are properly designed and executed." The experiments were properly designed and executed, thanks in part to expert assistance from professors at Georgia Tech, who worked as consultants to Hydro Dynamics. I think that Droege's self-appointed mission was to find a plausible excuse to dismiss the results. He could only do that by refusing to look.

Non-Profit Use Only

Chris Tinsley: Travels in the New Energy Age

...Weird Magnets, Wild Water, Moldova, Ohio, and all That

EDITOR'S NOTE: The following is a transcript of Chris Tinsley's highly stimulating talk at *Infinite Energy's* Cold Fusion & New Energy Symposium on January 20th. The only thing better than reading this is viewing and hearing Chris on video tape. Remem-ber, Chris hails from Nottingham, U.K. -- so, the talk is well done with a marvelous accent and good humour! Rush an order for your tape set today!

After all these excellent presentations you get a bit of intellectual relaxation now, because I'm not going to be communicating anything of great significance.

As Gene has said, he and Jed and I have worked together for several years now. In the early days I was busy with doing things like persuading the BBC to make the documentary which some of you saw at lunchtime, but latterly I've been more into the experimental stuff. Of course, some people have all the luck. Jed Rothwell has reported on the Patterson Cell - but all he had to do was to go to Anaheim, shove his shoulder between the guys who were standing in front of this thing, and get in there with his thermometers and flow-measuring equipment. He had to do a lot of hard talking to persuade them to let him do that, but strangely enough - having grudgingly let him do it - they are now passing out copies of his report! That's life in this business.

One of the things that came out of Gene and Jed's visit to HydroDynamics was the suggestion, (even at that stage as Jim Griggs will recall) that there was a possibility being considered that the excess energy was some function of a cavitation effect. Certainly Dr. Puthoff feels that collapsing microbubbles might be a way of tapping the so-called zero-point field. There were good feelings about this kind of device so, when at ICCF5 earlier last year we heard reports from Russia of a remarkable machine which would do the same but with no moving parts, we thought that it would be a good idea to investigate it. *[Editor's note: See issues #2 and #3 of IE.]*

The device itself is very simple. It has a swirl chamber at the inlet end, and water is fed into it under pressure. The vortex induced travels up the main tube, and the anomalous effect is supposed to occur in the tube. We are told that cavitation bubbles are formed in the body of the liquid itself as it moves up the tube, and their collapse produces the excess energy.

My investigation may turn out to have been wholly misleading, a lesson in just how confusing things can be. We are still not certain that the device doesn't work; what we are certain of is that it is just no longer worth the kind of effort which we've put in to find out whether or not it does. The best reports we have had have been from people as prestigious as Energiya, who make all the big boosters for the Russian space program. They confirm the over-unity performance of these machines, and, to be fair, some later tests I managed to arrange later in St. Petersburg converted one excellent and very skeptical physicist there to believing that there are indeed some energy anomalies in the machine.

I went to visit the inventor, one Dr. Potapov in Kishinev, Moldova, with a good friend of ours. He is Dr. Peter Glück from Romania, who speaks both Russian and English with great fluency. I must admit that I came away with a very good impression. On the video clip I'm showing, you'll perhaps see why. The fact is clear enough from the tape that Potapov has a thriving business in selling quite large and expensive machines for heating homes and offices and hotels.

However, these field trips are not necessarily quite what you would imagine. You might think of me flying out to some laboratory, where people discuss the devices and then get together to take the appropriate measurements. It's actually more like it is on the tape here, which makes me look rather ridiculous. I don't mind that, but in my defense I should explain that I had just taken a train from Bucharest to Kishinev. That takes fourteen hours because the tracks are different in the old Soviet Union, and the carriages have to be winched onto different bogies at the border. And I'd been misled about visa requirements, which meant I had some large ex-Soviet goons leaning on me about why I hadn't got one. Then I had been treated to an excellent lunch by Dr. Potapov, but that turned out to be a problem too. Comments had been made about Englishmen being unable to hold their drink - because it had not escaped notice that I had gone very easy on the vodka - and it was necessary to explain that any Englishman could drink any twelve Russians under the table. This news had been greeted with enthusiasm, but it meant that one thing led to another. I began the afternoon with half a litre of Blue Absolut vodka under my belt.

The film shows both sides of the story. On the one hand, there are the machines awaiting shipment - hundreds of them. On the other, all my efforts to test them came to nothing because the test I was offered would have meant me taking a great deal on trust. They wanted me to accept the water volumes, they wanted me to accept their thermometers, I think they even wanted me to accept the labels on the motor as being the true power input. I refused. We don't operate that way, we are not a bunch of wide-eyed enthusiasts, as I'm sure you've realized from Jed's talk. If we can't see for ourselves, if we can't take the measurements ourselves, then we cannot give any real support to the supposed performance.

But they are selling these machines by the thousand. Energiya say that they are 1.6 times over unity. Dr. Potapov was happy enough to sell us some of the basic tubes and tell me how we should drive them, but when we came to test them we got nothing. Maybe with unlimited funds and effort we could get to the bottom of all this, but it simply is not practical for us to do that. As Mr. Griggs would I am sure agree, these machines need very carefully adjusted conditions to behave, and with full cooperation we perhaps could have got good results.

That is the story - a rather sad story, too - of our adventures in Russia. But Gene has asked me to tell you something of my experience with the Sciex scooter.

This is another case study in investigation - this time with inconclusive but intriguing results, results we've been able to follow up. I went to London, to visit the home of the UK representative of the Japanese company Sciex. Mr. Takahashi, the head of the company, met us and showed us some of his devices. The most interesting one to me was a modified Taiwanese scooter, a bit like those Vespa and Lambretta machines. But this one was battery-powered, and was so heavy that I could barely lift one end of it. It had this rather small motor, maybe less than six inches in any dimension including its cooling fins. I think that the motor had been built into a housing from a more conventional unit. The four traction batteries were each twelve volt lead-acid gel type, quite small, perhaps about 20 amp-hours at most, at 48 volts. Apart from the batteries, there was nothing unusual except some conventional but large electrolytic capacitors under the seat. I asked if I could try it out, and they made no objection.

It seemed to me that the best test in a short time would be to abuse the thing as much as possible, to try to flatten the batteries. So I set off up a steep hill, and the performance was quite impressive. At one point I was doing about 50 mph up this hill, so I can believe the claim that the machine will do 70 mph on the level. The traffic wasn't bad, and there is a major road in the vicinity, but even so I couldn't use the full power of the scooter. That surprised me.

After about twenty-five minutes of hard acceleration and braking, I checked the battery voltage, which was 12.85 volts. That seemed suspiciously good. The brakes were quite hot, but when I came to check the motor it was virtually cold. Yet I had been using at least a few kilowatts for all that time. A test with the scooter on its stand showed that there was regenerative braking, because the battery voltage jumped up above 13 volts when I cut the power, then fell back to normal when it stopped. None of this proved anything at all, but the cold motor and the high battery voltage were certainly intriguing - to say the least.

Subsequently, I saw an article in the London Sunday Times about this scooter. It made me laugh out loud, because although there was no overt claim being made for anomalous performance the poor reporter had failed to realize how his article looked. He said that the scooter had a range of five hundred miles, he said all kinds of things about it. And how, we might ask, had this wonder been achieved? Ah, that was because Mr. Takahashi had switched attention away from the batteries. While everybody else was looking for better batteries for electric vehicles, Takahashi had decided to improve the motor.

Anybody should know that a motor for an electric vehicle is a pretty sophisticated unit - it has to be. It's probably a direct-current permanent-magnet type, with an efficiency which is almost certainly over 70%. There isn't any real slack in motor design, nothing which will give a startling improvement. That's why everybody is concentrat-

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ing on the batteries! In fact, the article was a blatant claim for over-unity performance - but not, apparently, to its author.

I asked Mr. Takahashi about this scooter. Was it over unity? Seemingly not. Apparently the magnets lose strength at about 3% per year, and Takahashi claims this to be the source of the energy. But he had a glint in his eye when he said it. When I said, "No, it isn't," he grinned.

In a situation like this, you have to ask the appropriate questions, even though you cannot believe the claims being made. So I asked him if the scooter would sustain itself indefinitely - as some of his promotional material graphs suggested without actually stating it. *[Editor's note: See article on Takahashi magnets in this issue.]* He said that it could probably do that on the level at a steady but reasonable speed, but that it couldn't under any road and traffic conditions because the motor wasn't good enough. And this was a fair answer - if we are to take these claims seriously at all. To work indefinitely in any conditions, the motor would probably have to be between 500% and 1,000% efficient.

We were then shown a videotape (made by somebody visiting, not Sciex), which showed one of his motors being started up on batteries and driving an alternator by way of a floppy plastic V-belt. The alternator in turn drove a pair of car headlamp bulbs. Again, there was nothing else apart from a few electrolytic capacitors. The battery was disconnected, and the motor just kept on running.

That means nothing - or does it? It means quite a lot, in fact. Any electric motor driving a belt which drives an alternator with a load of 120 watts will stop immediately when its supply is removed. Instantly! Which means that there is no possibility of error here. The logical alternatives are "real" and "fraud." Either Sciex have an over-unity motor - or somebody was underneath the table turning the handle.

Takahashi showed us some electric watches with no battery. I don't know whether there was a trick here, but the cases were transparent and I couldn't see any batteries. And some capacitors of supposedly 20 farad at 25 volts - in less than one cubic centimeter.

He then claimed that the magnets in his motor were such as to give a surface field of three tesla - 30,000 gauss. I've worked with the very best rare-earth magnets, and they have a surface field of just over one tesla. Pretty nasty and dangerous things, too, they can cut your hands as they jump and twist. So - three tesla? When iron saturates at about two? Pretty absurd, but now we hear that a big lab in the US has confirmed that these magnets are just as claimed - or better. *[Editor's note: Two labs have confirmed magnet performance, one in Massachusetts and one in California.]*

All this remains an open question. But this is no fellow wandering out of the backwoods with a supposed perpetual motion machine. Mr. Takahashi's resume shows him working as a senior man at Sony on important projects. His equipment is well made. At least one of his crazy claims has been shown to be correct. All this adds to his credibility, but I think he was in Europe to test the water and see how his claims were received.

His claims were received with all the enthusiasm which usually greets a rat sandwich, so I think he is backing off and concentrating on setting up a factory in the UK for his magnets, intending to slip the other claims in later. It's very common these days for Japanese companies to seek venture capital outside Japan, and manufacture in England or Wales. We and the Japanese seem to get on very well, and we even see their small children winning prizes at the cultural festivals - for the little poems they've written in Welsh!

One puzzle about the motor was that in each claim I ever see for such motors they have a non-linearity at one or more point in their rotation. Some have a kind of magnetic cam, or they are driven by a square pulse. But I couldn't see the non-linearity here until a friend at home pointed out - as Jan Roos noticed also today - that the magnets will saturate and unsaturate the iron core as the motor goes round. That will make this motor non-linear too.

I really do not know what to make of all this, so I've just reported what I've seen. Sometimes that's all we can do, but in this particular case the evidence is trickling in to improve the credibility. Takahashi wants recognition, but I don't think he has a serious case of Jed's "inventors' disease." Personally, I can't see why people want prizes and stuff, I don't see what is wrong with a villa in the south of France and being able to relax and happily tear up five-pound notes for the rest of your life.

Another example of our little investigations came - as Hall Fox has explained - from what he calls "The Cincinnati Group." Now Ohio may not exactly be the backwoods, and some interesting things have come out of it - like flying machines, for a start. But when a previously unheard-from group tells us they can take thorium through its billions of years of life to the usual daughter-products in a few minutes, or that they can make a fireball with only a few tens of watts and use it to melt asbestos sheet? Well ... you know.

But they invited Gene and his video camera, and he reported back some very interesting findings. And the group were very friendly and open. They even sent me some materials to try out, and they don't seem to want the Nobel prize.

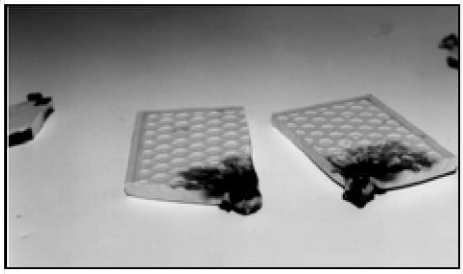
I did manage to replicate the melting, but some of my electrical gear was too small, so all I could manage was a brief test - with smoke coming from the other end of the bench as my own stuff started to die. I brought a few bits and pieces with me on the plane, and combined those with some of Gene's heavy gear. That meant that I did at least get the satisfaction of seeing Jed's face when the thing "ignited." It really is an astonishing process, especially since it is so very specific as to the materials which combine to give the effect - no other ones will do the trick. We have anecdotal reports that an air-flow calorimeter has shown the melting to be ten times better than unity, but lack of funding means that we've not done the experiments ourselves.

So here we have another set of claims which show themselves worthy of being investigated thoroughly, and we can recommend the group to anybody who's looking for some "weird science" to study. In fact, we hear that the thorium experiment has been confirmed elsewhere. Curiously, it is often easier to test that kind of thing than to do good calorimetry.

I see that I'm running out of time, that's good. But I'd like to add something about science and this "new energy" we've been talking about. Jed and Gene and I are very interested in the science of all this. We admire those scientists who are working on

A standard ceramic wall tile is melted by the "Cincinnati Group's" unusual electrochemical process that requires low power to sustain tile material boiling

this stuff. They are pretty brave, for one thing. When I went to Oxford University to meet with the Drs. Graneau - hi, Peter! - Dr. Neal Graneau felt it necessary to close the door of the room before talking about how others there view his work. At Oxford? At what must be one of the great bastions of academic freedom? And it is true enough that we will need to uncover the mechanisms of all this new physics. But I fear that we just can't do it properly right now. What we



Post "Burn": Tile is melted through at the center and is fractured.

believe is that these machines should be brought to the market. If you go with something odd to the scientists at a big company, they will tell you that there must be some mistake somewhere. (You will note that when anybody says that, they will most definitely not try to to find the "mistake.") But if the thing sells, then the Big Boss will tell the same scientists to find out what is happening.

They say that scientists will believe anything which they are *funded* to believe. That may be a little unfair, but the simple fact is that it is business which should fund this work - government won't - and business needs a reason for doing that. The reason should be that there is money in doing it.

All our efforts are directed to this goal of commercialization and subsequent proper research being done. I admire the scientists, I am deeply intrigued as to what these effects are; but I think we risk putting the cart before the horse. We are doing our part - investigating, working against Jed's so eloquently-described "inventor's disease" with its false dreams of power and glory, unlimited wealth and total "control of the development process."

We three are doing our best, but we are held back by lack of funds and by not being able to gear our best energies and abilities to the work that so desperately needs to be

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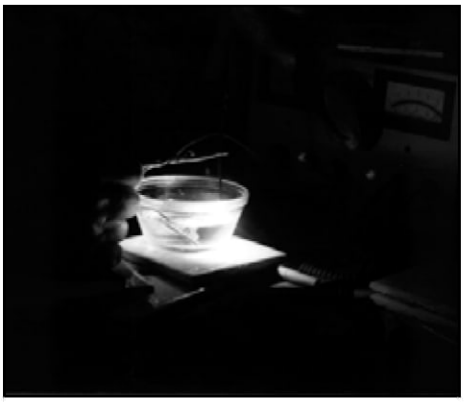

The Cincinnati Group's work has also led to liquid water electrolyte and electrode combinations that create a "plasma ball" effect *over* the water surface, which heats the solution rapidly.

done. But that is just another way of saying we are broke, isn't it?

Postscript

Since my talk, we have heard yet more stories of the Takahashi magnets, which are clearly living up to their claims. We have also heard some astonishing reports of Dr. Glück's recent visit to Dr. Potapov in his new headquarters. And there is considerably increased confidence that - despite our own lack of success, and our unhappiness with Dr. Potapov's way of dealing with us as his customers - that some vortex devices are indeed capable of providing over-unity heat at very high ratios. ∞

1996 Cold Fusion & New Energy Symposium (at the Cambridge Marriott, 1/20/96)

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The description of the Storms electrolytic cell and his experimental performance results are described in an article entitled *Measurements of Excess Heat from a PonsFleischmann-Type Electrolytic Cell Using Palladium Sheet: appearing in Fusion Technology*, Volume 3, Mar. 1993. In a previous article, Storms reviewed experimental observations about electrolytic cells for producing heat in an article entitled "Review of Experimental Observations About the Cold Fusion Effect" FUSION TECHNOLOGY, Vol 20, Dec. 1991.

None of the previously reported experimental results or other prior art devices known to applicant other than my U.S. '675 and '688 patents have utilized or disclosed non-conductive copolymeric beads of palladium coated (or any substitute metal which will form "metallic hydrides" in the presence of hydrogen) conductive microspheres within an electrolytic cell for the production of heat and the electrolysis of water into its hydrogen and oxygen components. The present invention discloses various improved embodiments of preferably palladium/nickel coated microspheres within an electrolytic cell in conjunction with an electrolytic media containing either water or heavy water, particularly deuterium. These improved microspheres are the subject of my co-pending U.S. application entitled "Improved Uniformly Plated Microsphere Catalyst, Ser. No. 08/452,005, filed Jun. 5, l995 ("co-pending U.S. application")

BRIEF SUMMARY OF THE INVENTION

This invention is directed to an electrolytic cell for electrolysizing water containing a conductive salt in solution and for producing heat. The electrolytic cell includes a non-conductive housing having an inlet and an outlet and spaced apart first and second conductive foraminous grids positioned within the housing. A plurality of nonconductive polymeric beads each having a conductive uniform preferably palladium plating over a nickel plating and an outer preferably nickel plating thereon are positioned within the housing in electrical contact with the first grid adjacent the inlet. An electric power source is operably connected across the first and second grids whereby electrical current flows between the grids within the water solution.

It is therefore an object of this invention to utilize preferably palladium coated microspheres as previously disclosed in my '675 and '688 patents in combination with the multi-layer arrangement of my referenced co-pending U.S. application for the production of either hydrogen and oxygen and/or heat.

It is another object of this invention to provide a variety of cathode constructions utilizing improved palladium/ nickel coated microspheres within an electrolytic cell.

It is yet another object of this invention to provide an improved electrolytic cell for the increased production of heat in the form of heated water or heavy water-based electrolyte exiting the cell.

It is yet another object of this invention to utilize metal coated conductive microspheres in an electrolytic cell, the metal chosen from those which exhibit strong hydrogen absorption properties to form "metallic hydrides" and structurally supported by one or more adjacent uniform support plates.

It is another object of this invention to provide an electrolytic cell for electrolysizing water and/or producing heat which is fault tolerant and having a long mean operating time to failure, if at all.

In accordance with these and other objects which will become apparent hereinafter, the instant invention will now be described with reference to the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a schematic view of an experimental system embodying the present invention.
FIG. 2 is a section view of the electrolytic cell shown in FIG. 1.
FIG. 3 is a section view of another embodiment of the electrolytic cell during flow of an electrolyte therethrough.
FIG. 4 is a partial section view of FIG. 3 with the electrolytic cell at rest.
FIG. 5 is yet another embodiment of the combined anode and cathode of an electrolytic cell of the present invention.
FIG. 6 is an end view of FIG. 5.
FIG. 7 is an enlarged section view in the direction of arrows 7—7 in FIG. 5.

DETAILED DESCRIPTION OF THEINVENTION

My prior U.S. Pat. Nos. 5,318,675 (U.S. '675) and 5,372,688 (U.S. '688) and the teachings contained therein are hereby incorporated by reference. Referring now to the drawings, and particularly to FIGS. 1 and 2, a system embodying concepts of the invention utilized during testing procedures is shown generally at numeral 10. This system 10 includes an electrolytic cell shown generally at numeral 12 interconnected at each end with a closed loop electrolyte circulation system. The circulation system includes a pump 18 which draws a liquid electrolyte 59 from a reservoir 32 and forces the electrolyte 59 in the direction of the arrow into inlet 54 of electrolytic cell 12. This pump 18 is a constant volume pump. After the electrolytic cell 12 is completely filled with the electrolyte 59, the fluid then exits an outlet 56, then flowing into a gas trap 26 which is provided to separate hydrogen and oxygen gas from the electrolyte 59 when required. A throttle valve 28 downstream of the gas trap 26 regulate the electrolyte flow so as to also regulate the fluid pressure within the electrolytic cell 12 as monitored by pressure gauge 20.

A slide valve 22 provides for the intermittent introduction of ingredients into the liquid electrolyte 59 via syringe 24. A second slide valve 30 provides for the periodic removal of electrolyte 59 into test reservoir 34 for analysis to determine correct electrolyte make-up.

In FIG. 2, the details of the electrolytic cell 12 utilized during testing procedures is there shown. A cylindrical glass non-conductive housing 14, open at each end, includes a moveable non-conductive end member 46 and 48 at each end thereof. These end members 46 and 48 are sealed within the housing 14 by O-rings 62 and 64. The relative spacing between these end members 46 and 48 is controlled by the movement of end plates 50 and 52 thereagainst.

Each of the end members 46 and 48 includes an inlet stopper 54 and an outlet stopper 56, respectively. Each of these stoppers 54 and 56 define an inlet and an outlet passage, respectively into and out of the interior volume, respectively, of the electrolytic cell 12. These end members 46 and 48 also include a fluid chamber 58 and 60, respectively within which are mounted electrodes 15 and 16, respectively, which extend from these chambers 58 and 60 to the exterior of the electrolytic cell 12 for interconnection to a d.c. power supply (not shown) having its negative and i positive terminals connected as shown. This d.c. power supply is a constant current type.

Also positioned within the chambers 58 and 60 are thermocouples 70 and 72 for monitoring the electrolyte temperature at these points of inlet and outlet of the electrolytic cell 12.

A plurality of conductive microspheres 36 are positioned within housing 14 immediately adjacent and against a conductive foraminous grid 38 formed of platinum and positioned transversely across the housing 14 as shown. These conductive microspheres 36 are formed of non-conductive inner polymer beads and include a uniform palladium plating layer. The preferred size of these conductive microspheres are in the range of l.0 mm or less in diameter and the details of the manufacture of these conductive microspheres 36 are generally taught in my previous U.S. Pat. Nos. 4,943,355 and 5,036,031. My co-pending U.S. application Ser. No. 08/452,005, filed on Jun. 5, 1995, entitled "Improved Uniformly Plated Microsphere Catalyst", incor- porated herein by reference, discloses the broad details of this improved conductive microsphere. These improved conductive microspheres 36 preferably include an inner nickel plate atop a metallic flash coat, a preferably palladium plate atop the inner nickel plate, and a support plate atop the palladium, preferably nickel.

In the previously reported testing in U.S. '675 and '688, an intermediate layer of nickel was alternately added over a copper flash coat beneath the palladium plate. The nickel intermediate layer, producing a mean microsphere density of 1.51 g/cm^3, was positioned immediately beneath the palladium plated layer to increase the density of the conductive microspheres 36. In this testing, a black residue developed within the liquid electrolyte which was subsequently analyzed and determined to be palladium. Further investigation showed that the outer palladium coat

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Brown Dwarf Discovery Confirms Theory of Spontaneous Energy Generation

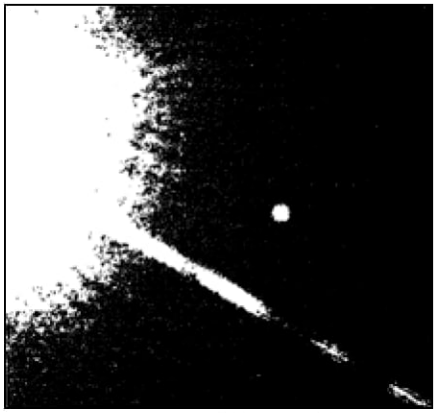
by Dr. Paul A. LaViolette

[Editor's Note: At the January 20th Symposium, Dr. LaViollete elaborated on this interpretation of an astronomical discovery and related it to present laboratory excess energy experiments.]

Observations of the mass and luminosity charac-teristics of the recently discovered brown dwarf GL 299B confirm Dr. Paul LaViolette's prediction that planets and stars alike are powered by a source of free energy which he has termed "genic energy."

The Planetary-Stellar Mass-Luminosity Prediction

In the late 1970's LaViolette developed a nonlinear system that effectively modeled many of the characteristics of subatomic particle and field phenomena and resolved many problems that plague standard physics (LaViolette, 1985, 1994, 1995). One of the inescapable consequences of this nonlinear system (known as Model G of the subquantum kinetics physics approach) is that photon energy is not necessarily conserved. Rather, photons gradually redshift (decrease their energy) in regions where Model G is subcritical and gradually blue shift (increase their energy) in regions where Model G is supercritical. [Such time-variation is a mode of behavior typical of nonlinear wave generator systems.] In Model G, the ambient value of gravitational potential is what determines whether the system is subcritical or supercritical and to what extent. Thus in intergalactic space where the gravitational potential is least negative, Model G will be subcritical and will cause photons to redshift (see LaViolette, 1986), but in the vicinity of galaxies where the gravitational potential is quite negative it will instead be supercritical. So photons residing within planets and stars will gradually blueshift and produce an energy excess (called genic energy). Since both the heat capacity and gravitational potential of a body are a function of its mass, there should be a specific relation between a body's mass and the genic energy luminosity that will radiate from its interior. As it turns out the exponent for this mass-luminosity relation is about what is found for the red dwarf M-L [Mass-Luminosity] relation. This led to the prediction that both planets and red dwarf stars should similarly conform to a common M-L



Brown dwarf Gliese 229B orbiting its primary star. Imaged with the Hubble Space Telescope (Courtesy of Nakajima, Kulkarni, Durrance, Golimowski, NASA).

relation. LaViolette plotted the intrinsic luminosities of the major planets against their masses and found that, in fact, they did fall along the low mass extension of the red dwarf M-L trend line (LaViolette, 1992, 1994, 1995). This "planetary-stellar" M-L relation, sometimes termed the "LaViolette Relation," also predicted that around 60 percent of the Sun's energy should be of non-nuclear genic energy origin, thereby resolving the solar neutrino problem.

The Brown Dwarf Mass-Luminosity Prediction

LaViolette noted that a further consequence of the genic-energy photon-blueshifting prediction would be that when brown dwarfs would be discovered they should be found to have mass luminosity coordinates that conform to the planetary-stellar M-L relation. Standard cooling theory, on the other hand, predicts no such conformance, except by chance coincidence. LaViolette clearly stated his prediction on several occasions (LaViolette, 1985, 1992, 1994, 1995). As it turns out, the mass and luminos*y coordinates for GL 229B, the first brown dwarf to be discovered, fall very close to the M-L relation. Its mass has been determined to be between 20 - 50 Jupiter masses and its luminosity is observed to be between 2 X 10^{-6} and 10^{-5} solar luminosities. The upper left hand corner of this M-L error box coincides with this relation. LaViolette has further predicted that as the mass and luminosity values of this brown dwarf become more accurately determined through future observation, this M-L coordinate should be found to lie even closer to the planetary-stellar M-L trend line.

As an example, if the recent Hubble Telescope measurements indicate that this brown dwarf has a luminosity of around 4 X 10^{-6} solar luminosities, the subquantum kinetics genic energy M-L relation predicts that this dwarf should have mass of around 0.013 (+ 0.006, -0.004) solar masses, or 14 (+5, -3) Jupiter masses. This range of uncertainty reflects the degree of data point scatter that characterizes the red dwarf M-L data.

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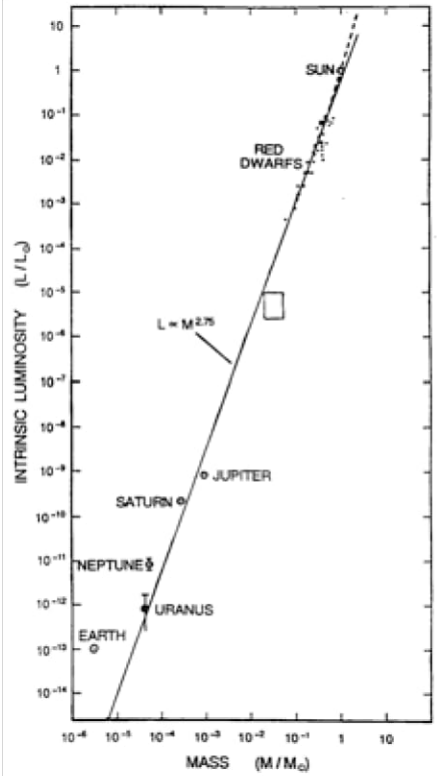
The books *Subquantum Kinetics* and *Beyond the Big Bang* may be mail-ordered from Starburst Publications, 1176 Hedgewood Lane, Schenectady, NY 12309.



The planetary-stellar mass-luminosity relation. The box represents the error box for the mass-luminosity coordinate for GL 229B.

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Transcript of ABC's Good Morning America Program, February 7, 1996, 8:16 - 8:22 a.m.

Prepared by the staff of Infinite Energy Magazine

A Report on Clean Energy Technology Inc. (CETI) Cold Fusion Device

Charlie: "Scientists discover a virtually limitless source of energy." Does it sound too good to be true? Maybe not. Our Science editor Michael Guillen is down in Washington this morning, having an exclusive look at an invention which has the potential of changing our lives. Michael?

Guillen: Thanks, Charlie. It's a device that its inventor says produces a hundred times more energy than it consumes. Now let me say right off the bat that lots of ideas come across my desk, that claim to be the energy source of the future, but this one is different. For one thing, the inventor has a distinguished track record. Second, the invention itself has been issued a patent by the US Patent Office. Furthermore, and this is key, independent scientists now claim to have reproduced the results, and major corporations like Motorola are taking a serious interest in it.

So, is this potentially the greatest discovery since electricity? Since fire? Good question! Have a look.

[Brief interviews]

James Reding, president Clean Energy Technologies Inc: We've been able to reliably demonstrate a device that produces a thousand times more energy out than you put into it.

Prof. George Miley, University of Illinois: What could it do as far as an electric power plant or a water heater in your home? There are so many applications that the mind can run wild.

Dr. C. Quinton Bowles, University of Missouri: It would be a true source of power for use by the general public.

Guillen: It's hard to believe, but here's what is causing all the commotion. It doesn't look like much - some wires, some salt water, and at the core of it: this container of tiny beads. But these are no ordinary beads, and the man who invented them is no ordinary person.

[Interview with James Patterson in his laboratory]

Patterson: I started making beads back in 1953.

Guillen: 74-year-old James Patterson looks about as homespun as his device, working out of a large garage in Sarasota, Florida, with more than a hundred patents to his credit. Patterson had always planned on being a chemistry professor but in 1951, while working for his PhD at Berkeley, Dow Chemical made him an offer he couldn't refuse.

Patterson: Dow hired me before I graduated, got my degree. And they paid me more than what I was going to get after I got my degree. So . . .

Guillen: It was during his years with Dow that Patterson invented a recipe for making tiny beads, beads so perfectly round that few people in the world can duplicate them.

Patterson: If I have a claim to fame, [laughs] I'm a good cook for little beads. Well, this is my storage area, and - it's almost like a library of what I've done.

Guillen: Over the years, Patterson's beads have been used in many different ways: in water purifiers, cosmetics, even as the 'talcum powder' inside surgical gloves.

Patterson: I'm better than a millionaire.

Guillen: Just because of the money you got from . . .

Patterson: . . . little beads! [laughs] I have converted alchemy ... little beads into gold!

Guillen: Talk about alchemy! In creating his new energy device, Patterson took his regular beads, and coated them with thin layers of copper, nickel and palladium; a metal sandwich Patterson claims works like magic.

Patterson: This is the guts of it, this is creating heat.

Guillen: So this is water that you have flowing through it. [Feels outlet tube.] Oh, it is hot. Pretty warm! Yeah. And so how much energy is this little cell putting out, compared to what it's consuming?

Patterson: One watt. It's consuming only one watt, and it's putting out two hundred watts.

Guillen: You know this sounds too good to be true?

Patterson: [Laughs] Well, it may sound too good to be true, but if you'll only look, the scientific evidence is here. I mean, you're looking at it. I mean, you can't disavow what you're looking at.

[Cut back to studio]

Charlie: Michael, alright, we're looking at it, but how's it working?

Guillen: Well, you know, even for a scientist like myself, you can't just tell by looking or even touching it. That's where the other scientists come in, at the University of Missouri, the University of Illinois, and at Motorola. They have tested dozens of these devices, they say they can't get it not to work. Every time you plug it in, the doggone thing just produces all this excess heat.

Charlie: But what's going on, scientifically?

Guillen.: Well, that's the big mystery. It's either, you know, an ordinary chemical reaction that's not behaving the way we expect it to, or some kind of a nuclear reaction. But there is no radioactivity that's evident from this thing so it doesn't appear to be a nuclear reaction. It's neither one nor the other, so it really is just a genuine mystery right now.

Charlie: Michael, what you are telling me is you have a scientific experiment that is producing a certain result and you have no idea how it's producing it.

Guillen: Yeah, but that's not unusual. I mean, very often times you run across something in the laboratory and you go 'wow! Look what it's doing' long before you understand why it's doing that.

Charlie: Michael, this sounds like going back to 19 . . . what? 1989

Guillen: 1989

Charlie: This sounds like the cold fusion debate again.

Guillen: Yeah. Remember the University of Utah, the whole cold fusion thing? Superficially this looks like cold fusion, in the sense that you have electricity passing through an electrode that is emersed in salt water. But there are essential technical differences. First of all the beads make this cell absolutely unique. That wasn't like the original cold fusion device. The other thing is that the original cold fusion device used heavy water, this uses ordinary water. So, it remains to be seen whether this is just a variation of the old cold fusion experiment or whether this is genuinely a new phenomena.

Charlie: Is there an anticipation that what is taking place here in microcosm can take place in a macro situation where you can produce a tremendous amount of energy?

Guillen: Now *that* is going to be the key question. If the scientists at the independent universities and corporations continue to verify that this device seems to work, the next question is going to be: can you scale it up from this laboratory model into something that can be mass produced, and be cost efficient. Because we have heard other alternative energy like wind power and solar power, they also sound

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great but they have never become cost efficient. That's going to be the big question in the future.

Charlie: You keep saying 'if this works.' You are telling me that a number of scientists have been able to make it work. There are also a bunch of other scientists who are saying this is just crazy.

Guillen: Yeah. The scientists are really cautious because of the old cold fusion flap six years ago. They want to be real cautious. The question is here, you have to measure the temperature differences, how much of the heat is putting out . . . is being put out by this device. That requires you to use thermometers of various kinds. They are just double, triple and quadruple checking those thermometers to make sure they are not misreading them. But they are all saying yes, this seems to work as advertised. So it's potentially historic.

Charlie: Five seconds: are you a believer or not?

Guillen: Uh, talk to me in about two or three months. We're going to be updating this.

Charlie: All right. Michael thanks. Michael will have more of this on Nightline, tonight.

ABC News Nightline Program Features Patterson Cold Fusion Device

by Jed Rothwell

On February 7, 1996, the ABC late night news program "Nightline" was devoted to James Patterson's cold fusion device, which is being commercialized by Clean Energy Technology, Inc. (CETI), of Dallas, Texas. It was titled "Patterson Power Cell: Fact or Fiction?" A shorter, five minute segment about Patterson, with the same film clips, was shown on the morning broadcast "Good Morning America" (see transcript of the latter adjacent to this article). The show was written and narrated by ABC's chief science editor Michael Guillen. The broadcasts included a long interview with Patterson, and brief interviews with Jim Reding, president of CETI; Professor George Miley of the University of Illinois; and Professor Clinton Bowles of the University of Missouri. The Nightline version included a short question and answer style debate between Michael McKubre of SRI and Prof. John Huizenga, retired from the University of Rochester, who was the head of the DOE ERAB panel that eliminated funding for cold fusion research in the fall of 1989. The program also had brief interviews with Patterson's patent attorney. ON the oposing side were Professor Herman Feshbach of the MIT Department of Physics (who totally denies the validity of cold fusion evidence), and Professor Howard Birnbaum of the University of Illinois, another negativist and member of the 1989 ERAB Cold Fusion panel.

In recent years, two serious, hour-long documentaries about cold fusion have been broadcast by the BBC in the U.K. and the CBC in Canada: "The Secret Life of Cold Fusion" (June 1993), and "Too Close to the Sun" (April 1994). The latter was a co-production of the BBC in the U.K. (where it is called the "Horizon" series) and the Canadian Broadcasting Corporation.

This ABC Nightline broadcast is, sad to say, the longest and most serious look at cold fusion in the U.S. television since 1989. Guillen did a short segment on Pons and Fleischmann in May 31, 1994, after visiting their IMRA laboratory in Nice, France. NOVA, the main U.S. science documentary program has totally abandoned its responsibility by having a complete blackout on news of cold fusion since 1990, when it broacast the atrociously negatively biased "Confusion in a Jar." A member of the NOVA staff— Evcan Haddingham- has discussed cold fusion with Eugene Mallove over the years and has told him that "they know they need to update their cold fusion coverage." Still, nothing has been done by NOVA —not even broadcasting "Too Close to the Sun," which NOVA could readily do if it so chose.

The Nightline program was generally positive and informative, although it had little scientific content. It began with a down-home interview with Dr. James Patterson in Sarasota Florida, and tour of his lab, which is, as he put it, "like a library of what I've done." It is filled with old chemicals, obsolete machines and junk. It was messy, but nowhere near as bad as the laboratories I have visited at MIT and the Japanese National Universities. It struck me as an ideal place to do research. Patterson, who is 74, briefly described his career which began at Berkeley and Dow Chemical. He is an expert in manufacturing small, uniform beads for a variety of applications. For example, microscopic beads are used as a man-made replacement for talcum powder in surgical gloves, and larger beads are used in catalysis. The latter application inspired Patterson to try them out as cold fusion cathode material. Patterson holds more than 100 patents for beads and other innovations, including, he told me once, a new type of fishhook. The bead patents have made him a multi-millionaire.

The shots of Patterson in his lab were fun but frustrating. You see him giving an animated, interesting and apparently informative scientific briefing, describing the instruments and methodology. Unfortunately, you cannot hear him because these segments are used as filler, background shots, with a foreground voice-over vapid script from the television writer. Turn the volume way up, listen and watch closely, and you see Patterson had some interesting things to say. If only the producers would say less and let him talk more we might have had some higher scientific content in this program. Even these short segments, and abbreviated glances at the chart recorder, beads, cell, pumps and other equipment convey a lot of information. Patterson claimed that 1 watt was input and 200 watts were coming out. Look carefully, and you can see the return water splashing into the pump reservoir, indicating a high flow rate. At one point Guillen put his hand on the outlet tube and declared: "It's pretty warm." I felt like shouting: "Okay Mike, now put your hand on the other tube and tell us about it." If they had shown a few more details like the input power supplies we could have worked out a ballpark estimate of the excess for ourselves. With the high flow rate and 1-watt input Guillen could not have felt any palpable difference between the inlet and outlet temperatures unless there was massive excess heat.

The program suffered from a curiously amnesic, dreamlike detachment. It is a story told in a vacuum, with no context, no background, no reference to history or other current research. The morning segment barely mentioned the term "cold fusion," except when Guillen said:

"Remember the University of Utah, the whole cold fusion thing? Superficially this looks like cold fusion, in the sense that you have electricity passing through an electrode that is emersed in salt water. But there are essential technical differences. First of all the beads make this cell absolutely unique."

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That would come as a shock to other researchers who have used thin film and nickel cathodes, and especially to Mills, who was the first to publish reports of excess heat from nickel. [1] Piantelli's gas loaded nickel experiments are unique, but Patterson's technique draws on many previous mainstream experiments. [2] There was no mention of the ongoing MITI/NEDO project, no mention of any work after 1989 (except Patterson's), nothing about the international conferences, and no hint that the literature reports widespread replications. Miley is shown working with the CETI thin film device, but Guillen does not mention that Miley published a paper describing his own thin-film cold fusion cathodes. [3]

Miley has independently replicated the CETI beads from scratch, and he has verified the performance of beads provided to him by CETI. He expressed confidence: "We've consistently measured excess energy coming out of it." Bowles has verified the performance of the CETI cells. He is funded by Kansas City Power and Light. He said: "These Patterson cells seem to be unique, and somewhat amazing, in the - in their reproducibility. . . . We have, in fact, had a total of three cells at different stages over the last nine months, and it's fair to say that all three of them appear to be producing excess power." Motorola's involvement was hinted at, just as it was in the *Wall Street Journal* article. [4] Guillen: "Already, says Patterson, Motorola has tested his cells and offered to buy him out." [Ed note: Motorola representatives were there in force at the CETI demo at the Power Gen '95 meeting in December.]

The second half of the program was devoted to a depressing debate between Dr. Michael McKubre of SRI Interna-tional, one of the leading cold fusion researchers, and Prof. John Huizenga, the "Darth Varder" against the field. I felt sorry for Huizenga, who looked old, tired, and nervous. He began by saying:

". . . let me simply say that since Pons and Fleischmann's results were shown to be flawed, there have arisen a whole array of exotic phenomena, including the synthesis of precious metals like gold, which would, of course, be the alchemist's dream, and the light water cells, I think, that are discussed . . . that Mr. Patterson is working on have all been shown not to be producing excess reaction products in the past, and I don't think these people have looked for the reaction products either."

Needless to say, from our point of view Pons and Fleischmann have *not* been shown to be flawed, they have been widely reproduced. But the real issue here is nuclear evidence: neutrons. Whenever the issue of excess heat comes up, Huizenga always evades it and talks about reaction products instead. In point of fact he is incorrect about this particular case. Miley and others are looking for reaction products. But Huizenga claims there are no neutrons and therefore there can be no nuclear reaction, and therefore the calorimetric results must be wrong. When asked for a reason why the calorimetry might be wrong, he always responds as he did here:

"I'm simply saying that what I know about these experiments, they're using an open cell and they're not taking account of recombination . . ."

At that point McKubre, who has heard this as many times as I have, could not help interrupting for a moment to say: "That's completely incorrect, completely incorrect." Huizenga went on to cite "many, many errors that they are making that have not been accounted for." He has often cited these many phantom errors, but he has never actually listed one of them. McKubre is quite right: the CETI results are far too big to be explained by recombination. The best results reported to date are 4,000 times beyond the limits of recombination, and furthermore CETI researchers do take account of recombination, with a precision gas flowmeter, so Huizenga is wrong on both counts. Huizenga was not aware of these facts, because, as he admitted, he has not actually seen or read about the CETI experiments. Herman Feshbach also claimed scientific clairvoyance:

"I don't know the device, so I don't know what's in it and what's not in it. I can only speak in generalities, and the one thing I can say unequivocally, without any concern, is that it's not a nuclear phenomenon."

This brings to mind Feshbach's famous 1991 pronouncement to Eugene Mallove:

"I have had 50 years of experience in nuclear physics and I know what's possible and what's impossible. . . . I don't want to see any more evidence! I think it's a bunch of junk and I don't want to have anything further to do with it."

Evidently, he now decided to make it a rule that he will see no more evidence, and that he can safely pontificate on national television about research he has never heard of.

Huizenga also claimed:

"It turns out that mainline scientists have spent hundreds of millions of dollars looking at all of these claims, and no one has been able to verify the cold fusion experiments."

He has often said this, but he never specifies which scientists have spend hundreds of millions. Japanese scientists have spent a hundred million (at least), and MITI has budgeted $100 million more over the next four years, but these examples do not count. The Japanese claim that they have been able to verify the cold fusion experiments. Huizenga is looking for an invisible army of researchers who have spent this kind of money and found nothing.

McKubre closed the debate by justifying continued research:

"Well, there is, in fact, no theoretical objection to the existence of a nuclear process occurring in a solid metal lattice. Given the fact that it is not theoretically impossible - and it's not - given the fact that people are observing it in numerous laboratories around the world, I think it would pay us to pay some attention to it, and the amounts of money that are being spent on this research are very, very small."

Video Tapes of ABC's news broadcasts can be purchased by dialing 1-800-913-3434. Transcripts are available from 1-800-255-6397. They can be delivered by e-mail for $10 per copy. This program was "Nightline (ABC) #3838."

Footnotes

1. Randell L. Mills and Steven P. Kneizys, "Excess Heat Production by the Electrolysis of an Aqueous Potassium Carbonate Electrolyte and the Implications for Cold Fusion," *Fusion Technology*, August 1991

2. S. Focardi, R. Habel, G. Piantelli, "Anomalous Heat Production in Ni-H System," *Il Nuovo Cimento*, vol. 107A, no. 1, Jan. 1994, pp 163-167

3. G.H. Miley, E.G. Batyrbekov, H. Hora, R.L. Zich, "Electrolytic Cell with Multilayer Thin-film Electrodes," *Fusion Technology*, Vol. 6, p. 313

4. J. Bishop, "A Bottle Rekindles Scientific Debate About the Possibility of Cold Fusion," *Wall Street Journal*, January 29, 1996

"The discovery of fission has an uncommonly complicated history; many errors beset it...Above all, it seems to me that the human mind sees only what it expects."

Emilio G. Segré, 1988
"The Discovery of Fission," December

New Energy Times Archive

Y. Takahashi Supermagnets to be New Force in New Energy

Photos: Courtesy, Sciex. U.K.

THE TAKAHASHI MAGNETS AND MOTOR

by Mark Goldes, CEO, Magnetic Power, Inc.
P.O. Box 880 Sebastopol, CA 95473

I had the honor to meet in London with Yasunori Takahashi, CEO of Sciex Corp. in early November 1995. Takahashi has invented new magnets with by far the highest energy products ever announced, as well as other desirable characteristics. The meetings were arranged by, and took place at the home of, Takeo Sawai, Secretary of Sciex (UK).

Using the latest versions of his extraordinary magnets, which data indicates are rated at 144.7 MegaGauss Oersteds (MGOe) – he has built a second, improved prototype of a scooter using his permanent magnet Self Generating Motor (SGM). Once started, using a battery, it appears to require no further input energy. The magnets and SGM are the subject of patent applications world-wide.

The September '94 issue of the British Broadcasting Company's *Top Gear* magazine described the earlier version of a similarly modified electric scooter that used less powerful, bonded, magnets (44.4 MGOe). The 144.7 MGOe magnets are sintered.

The BBC's magazine article describing the first scooter prototype stated: The motor was retrofitted with the magnets and the original batteries were replaced with four small 12 volt batteries (a 48 volt starting system). The scooter arrived in London with its batteries almost discharged. It was driven on a freeway at an estimated 70 mph (115 km/hr). It was also stated that that acceleration from zero to 30 mph took about 4 seconds.

The earlier scooter was demonstrated to a Senior Engineer at Nissan's European Technical Center who said that this invention: "If it checks out in our own tests, has huge implications for everything which uses a motor – it could revolutionize the world." He was given to understand that the batteries were only used to spin the motor up to a speed where it would continue to run without input. A video W8S shown by the inventor during my London visit which showed a prototype with a drive belt turning an alternator. The motor was connected to a battery for starting and the battery was then disconnected. Two (automobile) headlights remained illuminated after the battery was disconnected.

Another Invention demonstrated by Takahashl was an extremely powerful small capacitor. This unit, rated at 20 Farads at 25 volts, has a volume of about one cubic centimeter. Panasonic and three other companies have licensed this invention in Japan. A hot water thermos incorporating one of these capacitors was connected to the grid until the water boiled. For the next 24 hours, Takahashi stated it would bring the water to a boil again by pressing a button that released energy stored in the capacitor. It was on the table for several hours and boiling water was produced for tea a number of times

Takahashi has also invented a magnetic device Sciex calls a Battery Doubler®. Attached to a battery used for a cellular telephone, laptop computer, or a camcorder, during the charging process the data suppled indicates it will extend running time by a multiple of between 1.5 and 2.5. Magnetic Power Inc. will introduce the Battery Doublers into the U.S. market as the initial stage of a Joint-Venture between the two firms.

Curriculum Vitae

Yasunori Takahashi
Todoroki, Setagaya, Tokyo, Japan.

Date of Birth: 10th. Oct., 1940.

Education:

3-1963 Graduated from Tokyo University
12-1965 Study at Washington University (Electrical Engineering)
6-1966 (M. E.) Washington University

Work:

4-1963 Sony Corp. (2nd. Engineering Dept.)
Design & development of
transistor
transistor TV & video
chromatron
12-1965 Research for Ceramic High Tension Condenser with Murata Manufact. Co.
1-1966 Development of Chromatron for military use with Automeix (RCA)
Experimental Colour TV
1967 Research & development for Trinitron colour TV
1969 Trinitron colour TV
Development of Beta VTR
1970 Beta VTR, Omega Machine for NHK
1971/
1976 Stayed in Europe & USA for setting up factories.
1977 Development for Magnetic Camera, Mabica
1982 Mabica
1983 Resigned from Sony (General Manager for research & development)
1984 Founded Scitek Co. Ltd.
Act as consultant for
Kodak (Video)
Faiser Magnetic (Coating materials for video tapes)
1986 Changed the company name to Sciex.
1993 Invented YT Magnet
1994 Founded Sciex (UK) Ltd. (Director, R&D)

New Energy Times

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WHAT IS Y.T .MAGNET ?

A. Introduction:

Bonded Magnets are used in the several industrial fields. Basically, powdery raw materials of Ferrite magnetic and rare earth magnetic materials are mixed and bonded in plastic and rubber matrices.

Y.T. Bonded Magnet is processed by the quite new and unique produciton methods and is of the special crystal structure.

Y.T. Bonded Magnet means Glass Bonded Magnet with energy product of 46 MGOe. When this value will be converted as the Sintered Magnet, this energy product will surprisingly be over IOO MGOe.

B. Features:

(I) It is of the Glass Bonded Magnet of the anisotropic FeYbMnX with needle shaped crystal structure.

(2) As thc production method, chemical synthetic method is adopted to the production of Y.T.Magnet, which will not use the electrolytic iron as the starting materials at all, just like in case of conventional Bonded Magnet and Sintered Magnet.

(3) The production cost can be reduced to 20% - 30% compared with the conventional production methods.

C. Outline of Production Method:

In this production process, needle shaped powdery magnet will be produced from the raw materials of FeOOH in an atmosphere of a hydrogen-containing reducing gas.

The surface treatment will be made onto the aciculor powdery magnet and then metalic powder of the mixture of Cobalt and Yttrium will be mixed. The product thus prepared will be introduced into the rotary kiln in an atmosphere of Hydrogen (10%) and Nitrogen (90%) gas and produce the magnet alloy powder of FeYbMnX.

At this stage of preparation, size of powdery magnetic product has length of 9 μm and width of 0.9 μm of needle shaped crystals.

Then crystalized glass (2 - 4 wt%) will be mixed and magnetic moulding will be made at the temperture of ca. 500 °C, then Y.T. Magnet will be produced.

The Y.T .Magnet thus produced has the strong characteristics of Anti-Rusting and temperature range in use is
-55 °C~+125 °C ± max.5%.

The important point here is that the coercive force can freely be controlled by changing the mixing volume of Factor X.

BATTERY DOUBLER®

The Battery-Doubler is a super strong permanent magnet with the measurement of 30mm x 40mm x 1 .8mm. It consists of glass bonded RARE EARTH ELEMENTS. In spite of its small measurements, the magnetic pow-er of the Battery-Doubler comes to about 8000 Gauss, that means double as much as the magnetic power of a conventional permanent magnet.

The strong magnetic power of the Battery-Doubler makes it possible to charge Nickel-Cadmium Batteries, Lithium Batteries etc. more efficiently. If the Battery-Doubler is fixed on the Battery during the charging process, the so-called regular Ions Configuration will happen. (Fig. 1) This causes the capacity of the Battery to increase by 1.5 to 2.5 times as much as the conventional method used.

Fig. 2 shows the discharge curve of a pocket-telephone-Battery which is charged once with and once without the Battery-Doubler. Without the Battery-Doubler the pocket-telephone functions 2.8 hours, with the Battery-Doubler 6.5 hours.

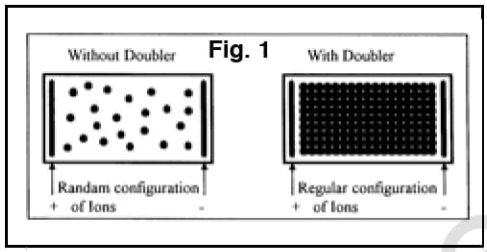

Fig. 1

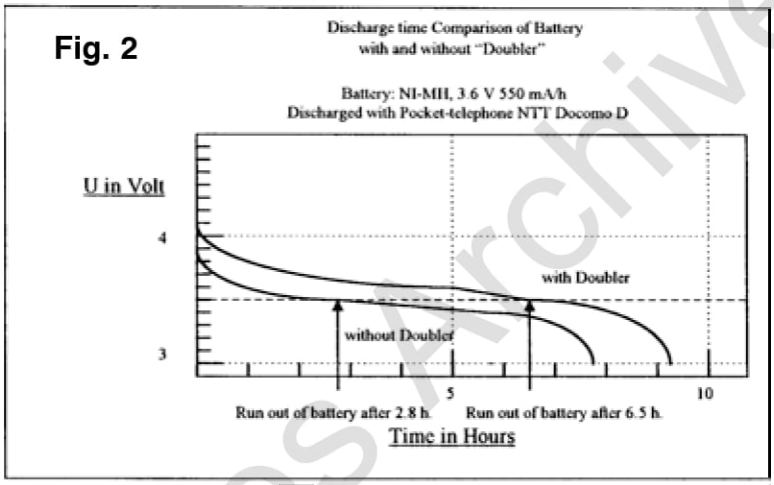

Fig. 2

Memory Effect

Nickel-Cadmium Batteries must be completely discharged before being charged again, otherwise a phenomenon called the Memory Effect will occur. In this case, the Battery will lose a part of its capacity, and the function duration will be rapidly reduced. The Battery-Doubler eliminates the Memory Effect.

Operating Instructions

• The Battery must be completely discharged before charging.
• Put the Battery-Doubler onto the Battery and start the usual charging procedure. Due to the magnetic field, the Battery-Doubler adheres to the Battery.
• Remove the Battery from the Battery-Doubler after charging has been completed.

Attention

Do not store the Battery-Doubler near magnetic tapes, credit cards, electronic apparatus, magnetic navigation equipment etc.

The Battery-Doubler consists of hard and brittle materials and is extremely breakable. Badly damaged/broken Battery-Doubler will lose their efficiency.

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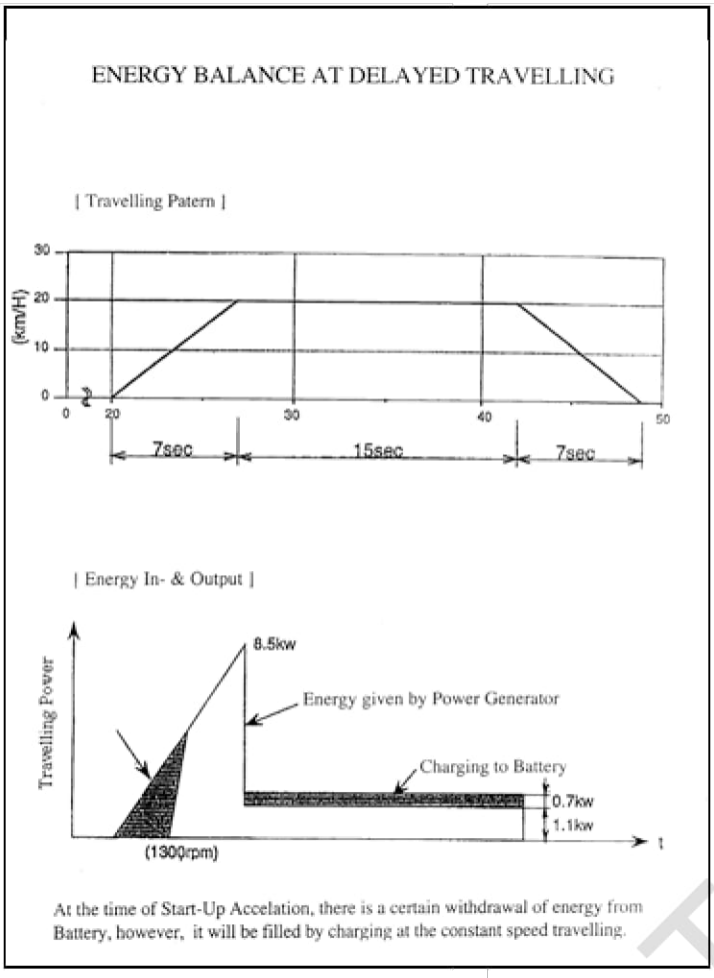
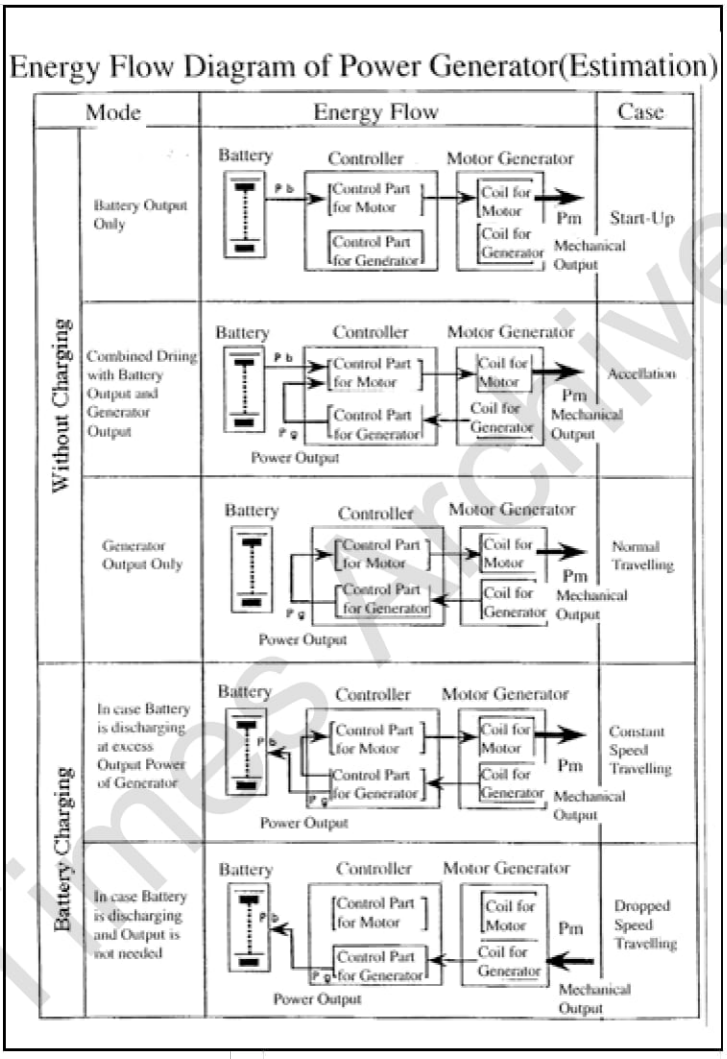
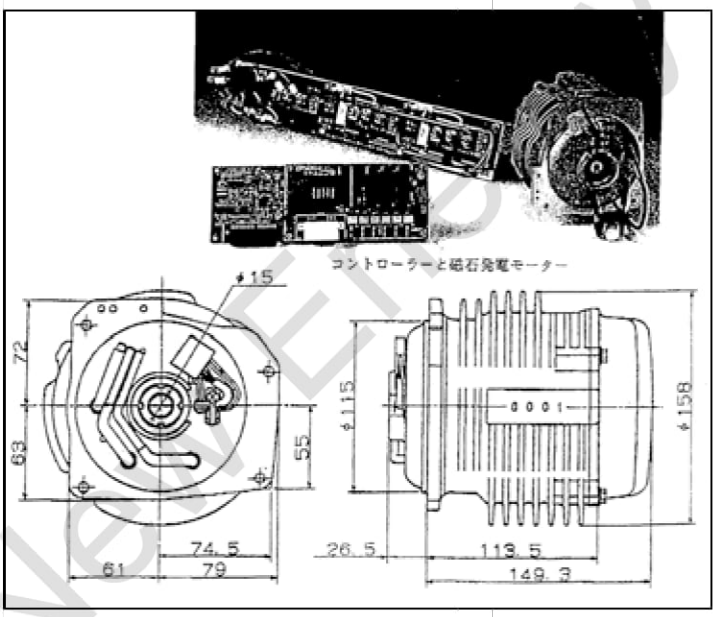


Takahashi motor characteristics suggest that battery is recharged during constant speed travel!





Takahashi Magnetic Generator/ Motor and Controller.

Specifications say 176 mm long, 7 kg mass.
Internal voltage: 48 VAC; AC Frequency: 8kHz;
External Power output: 100V, 30 A; BHmax 120 MGOe
FeSbMn sintered magnet; Curie point: 700 °C

Y. Takahashi's Recent U.S. patents:

#5,443,617, Issue Date: August 22, 1995; Filed Sept. 30, 1994. "Powdery Raw Material Composition for a Permanent Magnet" (2 claims, one drawing sheet) **Abstract:** The present invention aims at providing a powdery raw material composition for a permanent magnet superior in the magnetic properties and easy in preparation, a magnetically anisotropic permanent magnet, and a method for producing the magnet by use of powdery raw material composition. A powdery raw material composition for a permanent magnet according to the present invention is one prepared by subjecting a mixture composed of 13-18 weight % of a neodymium powder, 4-10 weight % of a boron powder and the rest of an acicular iron powder coated with aluminum phosphate to a temperature above 600 °C in an atmospher initially of a hydrogen-containing reducing gas followed later by an inert gas, and a magnetically anisotropic permanent magnet is prepared by comrpession molding a mixture obtained from the powdery composition and a binder under heating in the presence of a magnetic field.

#5,429,790 Issue Date: July 4, 1995; Filed March 25, 1994. "Method for Preparing Multilayer Dielectric Powder Condensers." **Abstract:** (Partial) The object of the present invention is to provide a method for preparing small-size and large capacity multilayer dielectric powder condensers capable of employing as the inner electrode materials inexpensive copper or nickel alloys.

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The Master Principle of EM Overunity and the Japanese Overunity Engines

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Summary

Conservative fields and single-valued potentials are universally assumed in rotary electromagnetic engine design and analysis, as is the absence of timed automatic *asymmetrical regauging*. Conventionally, a change of EM gauge is *symmetrical* and involves only a change of the EM potentials, while the EM force fields remain unchanged. No excess work of the form $\int \Delta \mathbf{F} \cdot d\mathbf{r}$ will be accomplished upon a system when it is symmetrically regauged to alter its potential, because $\Delta \mathbf{F} = \mathbf{0}$. Excess gradient-free EM potential (i.e., regauging) changes the stored energy in the regauged subsystem, and thus is comparable to a *refueling* process. However, unless an excess force is also produced and allowed to perform work on the system, the excess energy "collected" will not be dissipated to increase the kinetic energy of the rotary engine. Consequently the "free excess fuel will not be burned," and overunity will not result.

Customarily, Maxwell's equations (potential form) are *symmetrically* regauged by electrodynamicists to separate the variables. However, symmetry is obtained only by using two simultaneous *asymmetrical* regaugings, such that the resulting excess force fields offset one another. If the standard net symmetrical regauging is replaced by net *asymmetrical* regauging, then (i) excess potential energy can be freely received from the vacuum and stored in the system, and (ii) the excess force(s) produced can dissipate this excess energy to increase the kinetic energy of the rotary engine, thus permitting overunity operation without violating conservation of energy, the laws of physics, or the laws of nonequilibrium thermodynamics. *Equilibrium* thermodynamics —with its infamous second law — does not apply during the asymmetrical regauging because the engine is an open system freely receiving input of excess energy from an external source (the dynamic vacuum).

A schema for using dq/dt-blocking in a current loop containing a source, as a Poynting **S**-flow generator, is briefly presented and discussed. Since any source function is only to provide **S**-flow and emf, it follows that the source function alone does not involve dq/dt or **J**. The energy collection function in the receiving circuits involves dq/dt and the Slepian vector $\mathbf{J}\phi$. By bridging (dq/dt-blocking while passing **S**, emf, and $d\phi$ /dt) an otherwise conductive section between two dq/dt-isolated closed current loops, then voltage, **S**-flow, and emf may be freely bridged from the primary sourcing circuit onto the receiving loop containing the load. In short, the primary circuit can fulfill the source function of regauging its receiving circuit containing the load, without exchange of dq/dt or **J**. However, now no load current passes back through the primary circuit to dissipate its voltage source. In this way, multi-loop electrical circuits can perform asymmetrical self-regauging, thereby achieving overunity efficiency.

In a rotary engine with permanent magnet rotor, a ready means of *asymmetrically self-regauging* (ASR) a narrow sector of the stator is to utilize a *multivalued potential* (MVP) in that stator sector, so that the rotor suddenly experiences an instantaneous "jump" in its confronting stator potential and associated force field —as well as a change of sign (potential) and direction (force) if so designed—when it enters the multivalued region. In this fashion the potentialized vacuum itself directly and freely injects excess potential (stored energy) into the system during the multivalued potential jump, *refueling* the system. This asymmetrical potential is created with a gradient *a priori*, so that an associated "free working force" also appears. By placing the MVP in the normal "back drag"

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sector and reversing the sign of ϕ (and the direction of its **B**), the excess force produced therein will accelerate the rotor positively and increase its kinetic energy. This excess stored kinetic energy can then be dissipated as work in a load during the remainder of the rotary cycle. In principle this is no different than the refueling of a conventional gasoline engine, except that in ASR the vacuum's interaction with matter freely furnishes the "fuel."

Asymmetric self-regauging of a rotary electromagnetic engine thus can provide additional free potential energy from the vacuum and utilize (expend) it to provide additional kinetic energy in the engine, creating a permissible *Maxwell's Demon* of special kind.

A highly nonlinear single-valued magnetic scalar potential with radical magnitude changes in a stator region smaller than the finite domains of the rotor can be utilized as a "pseudo MVP," since a rotor domain will experience this rapid alteration of the magnetostatic scalar potential in a single domain as a nearly instantaneous "jump". Even over several domains, a sharply-changed, single-valued potential with a finite rise time can be used if the resulting primary **B**-field is radially oriented so that no back-drag results on the rotor. Even for back-drag, the jump time dt can be made sufficiently small so that the overall $\int F(t)dt$ "back impulse" becomes negligible, vanishes, or even reverses. The jumped potential can be appreciably higher than that of the next forward tangential stator region and of like sign. In that case a strong tangential force freely results which *accelerates* the rotor and adds energy to it, bleeding off the energy from the change in potential. Consequently, immediately after the jump the rotor can experience a substantial net overall boost out of the pseudo MVP jump region, and increase its kinetic energy, as formally proven by Johnson's permanent magnet gates in actual laboratory force-time measurements every 0.01 sec, and as utilized in Takahashi's electromagnetic engine.

Explanations of the Johnson boosting stator gate and the Takahashi and Kawai engines are presented from the viewpoint of the potentials and asymmetrical self-regauging. The explanations and the overunity mechanism are straightforward once ASR and the pseudo-MVP jump mechanism are understood.

It appears that the Japanese may be developing an extensive line of these overunity electromagnetic engines for powering electric vehicles, with little or no need for externally recharging the vehicle battery. To maintain scientific and industrial viability, the scientific and industrial communities of other nations must focus attention upon the principles of these engines in their own research, development, and production.

Table 1: Asymmetry and modern physics.

* Per T.D. Lee, Particle Physics and Introduction to Field Theory, Harwood Academic Publishers, New York, 1981, p. 378-390.

SYMMETRY AND MODERN PHYSICS
- Missing symmetry of matter
- Symmetry only of mass and vacuum
- Vacuum excitation
- Vacuum structures
- Spontaneous symmetry breaking
- Interaction between matter and vacuum
- Possibility of vacuum engineering

SOME PROVEN ASYMMETRIES
- Positive and negative signs of electric charge
- Time reversal
- Right/left handedness

STRONG LOCAL ASYMMETRY
- Properties of object may differ appreciably for:
  - Different observers
  - Different detecting means
  - One time to another
  - One position to another

STRONG LOCAL ASYMMETRY (CONT'D)
- Local spacetime is curved
- Lorentz invariance of vacuum violated
- May be local sink or source
- EM gravitational/inertial effects
- Translation between virtual and observable
- Electrogravitational solitons
- Action at a distance
- Transmutation effects may exist
- Scalar/pseudoscalar field translation

WHEN SYMMETRY IS VIOLATED
- A "non-observable" turns out to be an observable
- An invariance is broken
- A conservation law or selection rule is broken

COMMENTS:
- A virtual object becomes an observable object
- Local spacetime becomes curved, at least to some potential involving that object

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Introduction

First some background information. In 1980 I wrote an informal (at the time proprietary) paper pointing out the significance of multi-valued potentials for enabling overunity operations of electromagnetic processes.[1] In a 1989 article[2] we proposed one method (one of Howard Johnson's methods) for an overunity permanent magnet motor without ancillary electromagnets.[3] In 1993 we openly proposed a mechanism for obtaining "free energy" from the vacuum in electrical circuits,[4] and followed that by filing a patent application and a follow-on continuation on the method and various embodiments.[5] My associates and I followed with patent applications for room temperature superconductivity, Poynting energy generators and enhancers, and other related overunity embodiments.[6] We are presently struggling to ready four other patent applications in this rapidly emerging overunity field.

In a recent article[7] we cautiously pointed out potential Japanese overunity motor work.[8] With somewhat limited information on engine details and no test results of the reported Japanese overunity engine(s), such caution was appropriate. Therefore we assigned a probability of perhaps only 60% that the work was overunity.

Such caution was justified. In the preliminary electric motor scooter demonstrations held for Western engineers in Europe, no one was permitted to examine the actual motor "under the hood," so to speak. Therefore a question remained, because *independent certification tests*—at least by Western scientists and engineers —had not appeared. Nonetheless I felt that 60% probability existed that the Japanese engine or engines were true overunity engines.

Additional Information on Japanese Overunity Engines

Additional information on these Japanese engines is now available. A fundamental U.S. patent[9] on an overunity engine (test numbers are clearly stated in the patent for overunity coefficient of performance of some 318%) has been issued to Japanese inventor Teruo Kawai. Dr. Eugene Mallove has followed up this startling development by printing an excerpt from the patent, with a commentary,[10] and also the transcript[11] of a Fuji Television Network program (some eight minutes) aired on October 20, 1993 over Japanese Television, and dealing with "dream energy" from permanent magnets. Additional tests of the Takahashi motor scooter have been reported, and the Takahashi engine may now be considered as verified overunity.

The Japanese appear to have had a substantially funded, national strategic program in overunity motors and devices for at least twenty years. For example, it is well-known that the Japan is heavily involved in cold fusion research. Also, as early as 1979, a 45 h.p. motor — invented by Takahashi — was being tested in a Mazda automobile.[12] As we shall see, a gauge-theoretic analysis of the Takahashi and Kawai engines and of the Johnson boosting permanent magnet stator gate, supports the technical capability of such engines and devices to produce overunity coefficient of performance, because of their use of *asymmetric self-regauging* (ASR).

The present paper explains some elementary gauge-theoretic concepts needed to comprehend overunity EM circuits and machines. It also proposes a master overunity principle —asymmetrical self-regauging (ASR) —and explains the appli-

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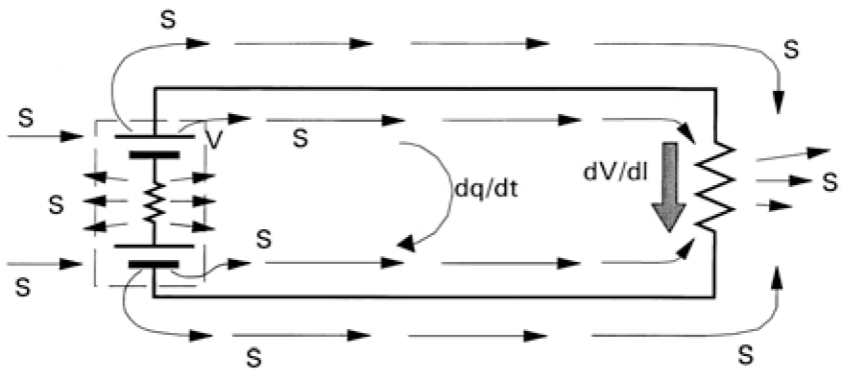

Note: EM texts err in showing the battery "gate" as the source of energy.

From particle physics, any electric charge is a broken symmetry in the vacuum's virtual particle flux. Any dipole is thus two locally broken symmetries. Thus the dipole acts as a gate/source, driven by the fierce vacuum flux. So a dipole already "extracts" and gates EM energy flow, directly from the seething vacuum.

Every battery and generator is already a "free energy" source of extracted and gated EM energy from the vacuum.

Figure 1. Poynting S-flow along a simple circuit.

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overunity principle —asymmetrical self-regauging (ASR) —and explains the application of this principle in overunity electrical circuits, the Johnson permanent magnet boosting stator gate, and the Japanese overunity EM engines.

What is Required to Explain Electromagnetic Overunity

As is well-known in thermodynamics,[13] any permissible overunity system must involve an open system which receives an input of excess energy from an external source.[14] In other words, the open system must not be in thermodynamic equilibrium. This is important. If the system is open but in thermodynamic equilibrium, it is prohibited from receiving *and storing* any excess input of energy that can then be gated to a load to power it. Therefore the open system in equilibrium cannot exhibit stable overunity coefficient of performance. So the first requirement is to explain how the system breaks thermodynamic equilibrium.

In the case of all three engines, it is important to detail exactly how the excess energy is input into the engine, and show how the system is indeed an open system freely receiving this excess energy from a recognized external source. In short, one must show (i) what the external source is, (ii) how and why the system is indeed an open system, (iii) why it is not in local equilibrium, (iv) precisely how the system receives its "free" input of excess energy from the external source, and (v) what is necessary in order for this excess potential energy to be dissipated as work performed upon the rotary system to increase its kinetic energy.

Energy Can Be Extracted from a Magnetic Dipole

Johnson has now permitted release of the major principle behind his rotor-accelerating magnetic stator— which accomplishes asymmetrical self-regauging by means of a pseudo-multivalued scalar magnetic potential. A patent is in preparation on the process and embodiments. There appears to be no explanation in the Kawai patent or the Takahashi literature as to how the excess energy is arrived at, or what is its exact external source, except for vague reference to "extracting energy from a permanent magnet." To conventional electrical engineers, that kind of statement has long been deemed nonsensical. It is our purpose in this article to show that it is not nonsensical after all, from a gauge-theoretic view.

But first we must break away from exclusive use of conventional EM theory and analysis. *No engine which operates entirely in accord with the standard "closed system" EM textbook model can exhibit an overunity coefficient of performance, because all fields in the conventional theory are already made conservative.* A priori, one must put as much energy *into* that engine to run it, as one can possibly *get back out of it* in the form of work and its losses.

So the first issue is, "How do we create and utilize a nonconservative field in the candidate overunity system?" Some background will be necessary before answering the question.

Asymmetry, Conservation, and the Modern Vacuum

In the standard electrical power engineering model it is assumed that the vacuum has no interaction consequences upon an operating physical system. Consequently many symmetries abound. Indeed, to every conservation law there can be assigned a symmetry. The conservation laws favored by power engineers thus can be regarded from the standpoint of their symmetries. It can come as a profound shock that the assumed symmetry of physical actions in physical systems *does not exist* unless the interaction of the vacuum with the physical matter is included. This is well-known and long since proven in particle physics, but it is absent from electrical power engineering.[15]

In material particulate systems, there are three major symmetries —charge, parity, and time—that *individually or even in pairs* need not be obeyed. The requirement is that not all three can be broken simultaneously, in accordance with the well-known CPT theorem of particle physics. In other words, violations of each of the three, and of pairs, have been individually shown; but violations of all three at once have not been found. Violations of each of these symmetries can be most interesting and novel.

For example, local violation of time symmetry yields a local violation of the conservation of energy law, because energy and time are canonical.[16] Electrical charge alone is *not necessarily individually conserved, regardless of what we are ordinarily taught in electrical engineering.*[17] Nature allows charge to become asymmetrical if the vacuum interaction is sufficiently asymmetrical; one must just discover how to do it.[18] Table 1 is a synopsis of some major aspects of asymmetry in modern physics.

Our point is that overunity EM machines must a priori involve one or more broken symmetries. This alone voids any "conventional EM" justification, because it voids any model which ignores the vacuum's interaction with matter and/or which is symmetrically closed. So to ascertain the exact nature of the "external source" that is furnishing the excess energy to an open system with broken symmetry, it is only necessary to realize that *a priori* the source becomes the quantum mechanical vacuum, according to well-established particle physics. Let us examine this a little more closely.

An Electrical Charge Is Already a Broken Symmetry

First, any electrical charge[19] is already a proven asymmetry. According to particle physics and the theory of curved space-times, that charge must act either as a gating *source* or a gating *sink* in the fiery flux of the local vacuum. In common terms, that charge is either *extracting and gating*[20] energy right out of the quantum mechanical vacuum[21] and thereby acting as a free energy source, or it is gating energy back into the quantum mechanical vacuum and thereby acting as an energy sink.[22]

This immediately puts a different perspective upon an electrical dipole. It is

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simultaneously similar to a powerful energy spray pump (an energy source) on one end and an energy suction pump (an energy sink) on the other end. Electrical field energy (charge flux) is flowing from the vacuum out of one end of the dipole, and from the other end back to the vacuum—all *driven* by the vacuum.[23] In general, a Poynting flow must be perpendicular to the field lines, by its definition **S≡ ExH**. More conventionally, electrodynamicists assume (for 2-wire circuits) that two **S**-flows of energy are produced, one from each of the ends of the dipole. There is a net difference between these two flows and therefore a net potential difference between the ends of the dipole.

Among leading university EM textbooks, perhaps the best struggle with the flow of Poynting energy in electrical circuits is undertaken by Krauss. Figure 1 shows a partially corrected flow of the Poynting energy in a simple electric circuit, after Krauss and extending his presentation. As can be seen, the flow of Poynting energy originates in the vacuum and returns to the vacuum, contrary to present electrodynamics textbooks. The external circuitry is just the "gating" and "wave guiding" applied to this energy flow, that is freely extracted from the vacuum flux by the dipolar source. Simply eliminate the external circuit, the battery and its internal resistance, but retain the separation of positive and negative charges, and one has arrived at a dipole. *The free flow of Poynting energy from any source is due to this dipole*, not to the overall battery per se.[25] The battery or generator is just the mechanism that creates and sustains the dipole.

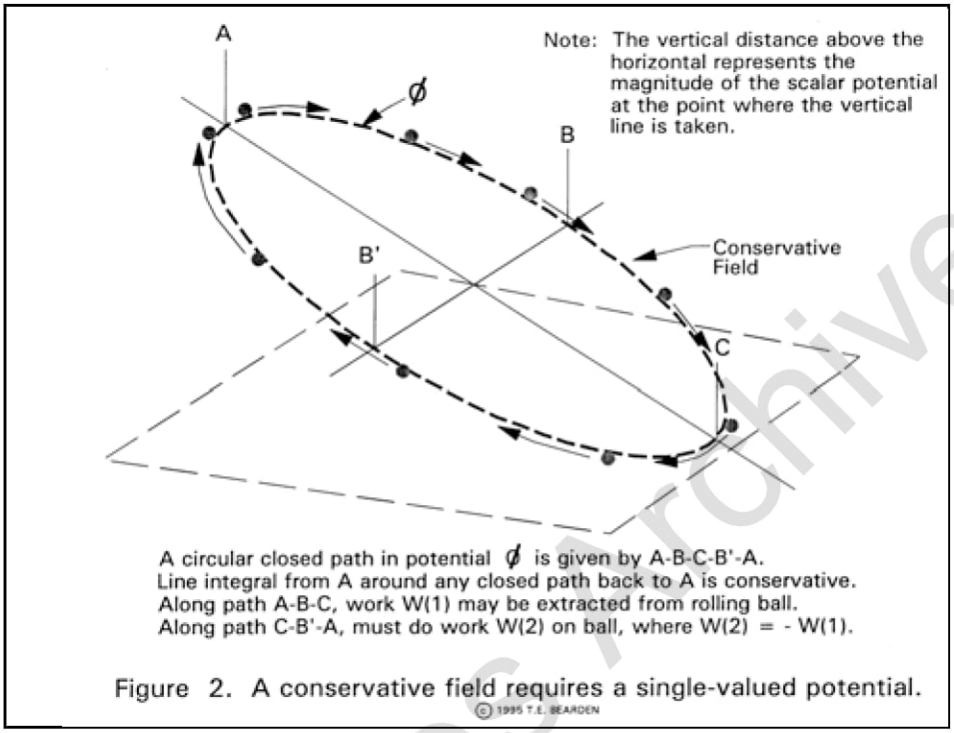

Figure 2. A conservative field requires a single-valued potential.

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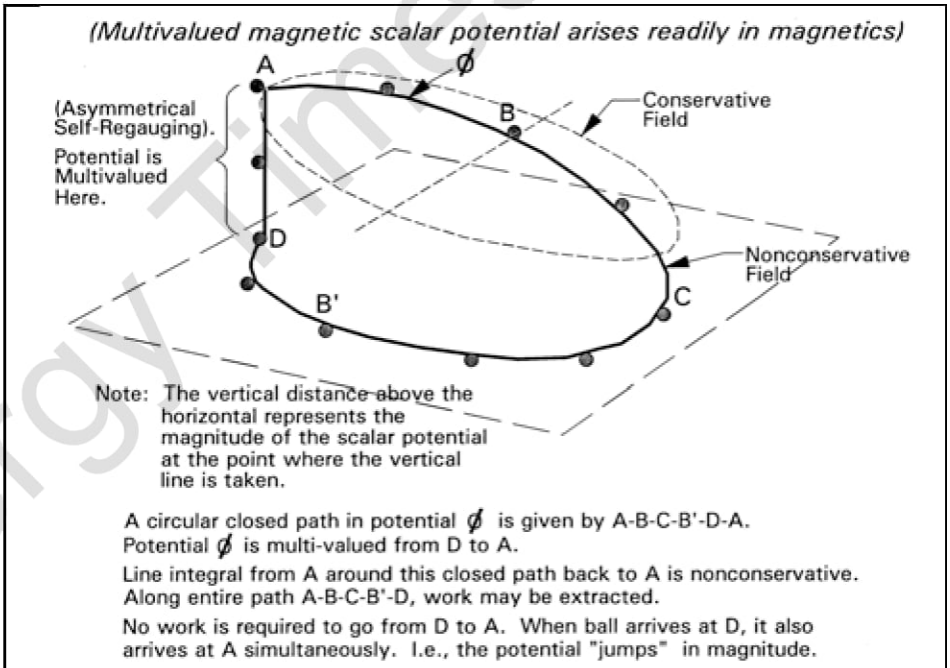

Figure 3. Field May be Nonconservative for a Multivalued Potential.

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Every Electric Dipole Is Already a Free Energy Source

Every electric dipole in the universe is already a legitimate, proven, free energy device that directly extracts and gates energy from and to the active vacuum.[26] Such a *free energy device* is already included in every battery and generator ever built. It will persist so long as no internal work is done on the charges making up the source dipole, to *destroy* their separation.

One does not have to discover how to extract free energy from the vacuum. One just has to learn how to properly use the free energy extractors *universally* available already.

We now have identified the energetic vacuum as a legitimate primary source of free energy from any dipolar electrical power source. From the seething vacuum, the dipolar source will extract two flows of Poynting energy (we will model it that way). The external conductors will gate and guide the Poynting energy flows **S** — each along with its concomitant emf and voltage —to the external circuit *indefinitely*, so long as the separation of the charges comprising the source's dipolarity is undisturbed.[27]

A Magnetic Dipole Is Also a Similar Free Energy Source

A similar asymmetry also exists for any magnetic pole (magnetic charge, or magnetostatic scalar potential). A magnetic dipole —any common, ordinary permanent magnet, for example — thus legitimately is already a proven *free energy-flow generator*. A flow of Poynting energy is moving (by convention) everywhere between its north pole and its south pole, orthogonal to the magnetic field lines. This free flow of Poynting field energy *from the vacuum* will continue as long as that separation of poles exists in the magnet.

One can also represent a magnetic pole as a magnetostatic scalar potential. It is thought that we do not have moving "**j**Φ" type material magnetic charges in the magnet,[28] but we have moving massless d Φ/dt. In the more accurate particle physics view, we have moving virtual photons, moving along the field lines. Unknown to present theorists, we also have moving virtual antiphotons, moving along the field lines in the opposite direction. In the dipolar atom, the time-forward photons interact with the time-forward electron shells, while

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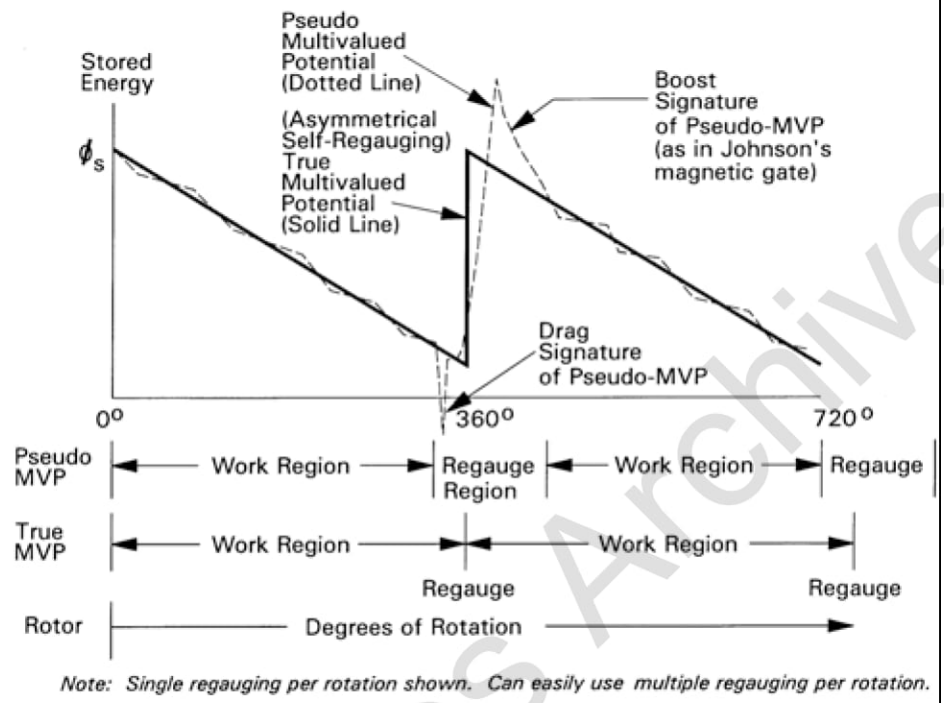
the time-reversed photons (the antiphotons) interact with the time-reversed nuclei.

Regauging a Magnetic Scalar Potential

To asymmetrically "regauge" a magnetostatic scalar potential on a stator so as to *enhance* the engine's energy and operation, ideally we must create or increase a stator magnetic pole in such a manner that the direct excess magnetic field **H** from the suddenly injected change in pole strength cannot decelerate the rotor *in the regauging region itself*. Specifically, the designer must arrange geometry and timing so that a tangential *acceleration* force is created upon the rotor between the regauging region and nextmost regions beyond it. Such a free force which tangentially accelerates the rotor from the regauging region to the nextmost stator region can be highly beneficial. It can "energetically reset" the "spent" portion of the engine, over-ride the otherwise back-drag region and convert it to rotor acceleration, and thereby enable overunity efficiency. In fact, that is the active principle used by both Takahashi and Johnson. [See Figures 10 and 8]

On the other hand, Kawai's engine [Figure 9] creates a tangential force field by a stator electromagnet when it is just forward of the radial flux from a central ring magnet. This produces a conventional accelerating tangential force field, which reduces as the rotor proceeds and the flux becomes aligned with the stator electromagnet. If unchanged, the tangential force component would then reverse in direction and add back-drag to retard the rotor. Just as the tangential force approaches zero and its reversal, the Kawai engine asymmetrically self-regauges by de-energizing the stator electromagnet and resetting that stator coil's magnetic scalar potential back to zero. Hence the asymmetrical self-regauging "quenches" the back-drag field portion. This in turn now makes the overall field situation *nonconservative*. Rigorously, overunity operation is permissible.

Asymmetrical regauging (ASR) is best accomplished by creating the magnetic **B**-field of the injected pole oriented radially with respect to the rotor pole in the regauging sector, as that rotor pole moves along its tangential path. In that case, no *radial* work on the rotor system will occur to uselessly drain off the excess energy in the regauged magnetic scalar potential. With the radial B-force from the regauging "bottled up," the injected magnetostatic scalar potential (altered pole strength) from the regauging can readily be made sufficiently strong as to create a tangentially accelerating force between itself and the potential (pole) nextmost in rotation order. Thus the rotor can actually be strongly accelerated "for free" through a region that would otherwise produce back-drag deceleration if asymmetrical self-regauging were not accomplished.



Note: Single regauging per rotation shown. Can easily use multiple regauging per rotation.

Figure 4. "Refueling" an EM Engine by Asymmetrical Regauging with MVP.

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Once the ASR jump of the magnetostatic scalar potential (MSP) is accomplished, the tangential back-drag on the rotor in a permanent magnet motor arrangement can be eliminated or materially reduced — *or even reversed so as to aid the rotor's operation* — with the expenditure of very little energy in creating the "regauging jump." That is the ASR gauging secret of the Takahashi and Johnson engines. Takahashi employs a breaking of a small current through a radial stator coil in order to induce a momentary, free, very high MSP with its **H** field radial to the rotor. This produces a large, *amplified* magnetostatic scalar potential[29] "jump" so that the usual "tangential back-drag" force — between the regauging region and the stator region directly ahead — is actually *reversed* and now strongly aids in accelerating the rotor's movement out of the regauging region. Both the Johnson engine and the Takahashi engine are *"convert decelerating drag into accelerating boost" engines, while the Kawai engine is an "eliminate decelerating back drag"* engine.

It is important to note that the ASR "jump" region becomes an *energy reset and refueling* region. It is just like refueling a gasoline-powered automobile — by refueling, one resets the stored energy (i.e., the potential) in a subsystem (the gasoline tank) to its desired initial value. The excess fuel is then expended by the associated excess regauging force, to increase the kinetic energy of the rotary engine, which in turn is dissipated to power the load.

For overunity operation, the engine simply resets (refuels) itself, extracts and dissipates the "excess fuel" energy as work in the load, resets (refuels) itself again, extracts and dissipates more excess energy in the load, and so on.

The Technical Basis of Regauging Maxwell's Equations

For asymmetrical regauging (A-regauging) considerations, we are speaking of altering the Poynting energy flow in a circuit,[30] as well as producing excess force(s). This means that the energy is in field energy (**E**-field and **B**-field) form, either overtly or "infolded" inside the corresponding scalar potentials,[31] or both. Consequently, we must analyze Maxwell's equations as we would for radiating energy, rather than employ only the "current and voltage" type circuit analysis conventionally utilized, where the collected energy is sluggishly transported by the Slepian vector $j\Phi$.[32] We show in this paper that asymmetrical self-regauging (ASR) allows permissible overunity operation of electromagnetic engines and devices.[33]

In Gaussian units, Jackson[34] shows that Maxwell's four equations (vacuum form) can first be reduced to a set of two coupled equations in the (**A**, Φ) representation as follows:

$$\nabla^2\Phi + \frac{1}{c}\frac{\partial}{\partial t}(\nabla\cdot\mathbf{A}) = -4\pi\rho \quad [1]$$

$$\nabla^2\mathbf{A} - \frac{1}{c^2}\frac{\partial^2\mathbf{A}}{\partial t^2} - \nabla(\nabla\cdot\mathbf{A} + \frac{1}{c}\frac{\partial\Phi}{\partial t} = -\frac{4\rho}{c}\mathbf{J} \quad [2]$$

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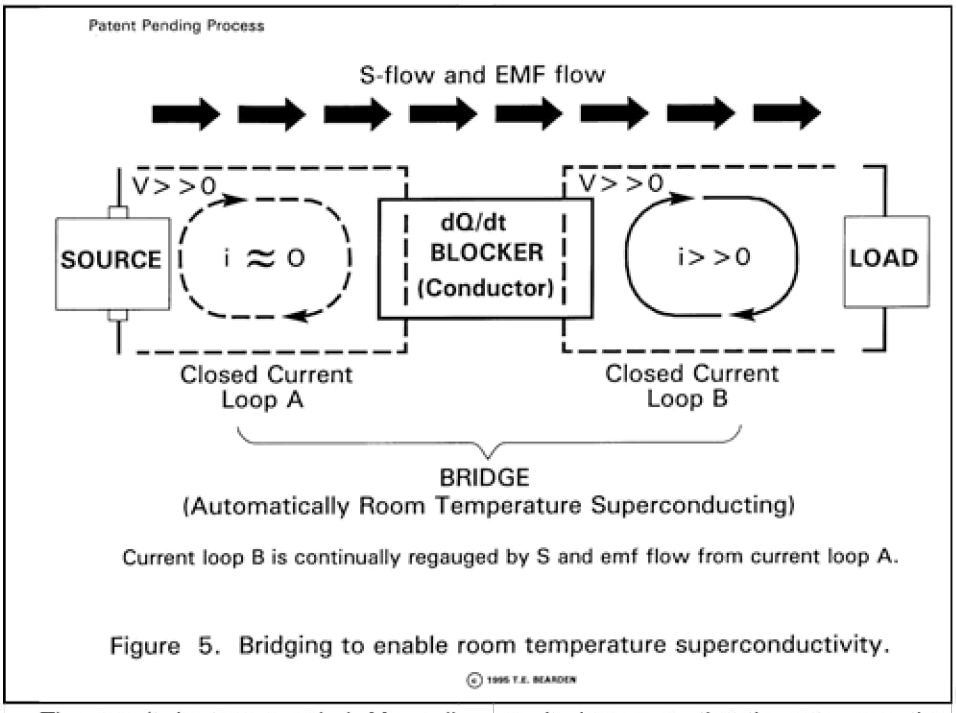

Figure 5. Bridging to enable room temperature superconductivity.

The result is two coupled Maxwell equations rather than four. Jackson shows that potentials **A** and Φ in these two equations are arbitrary in a specific sense. E.g., the **A** vector can be replaced with **A'** = **A** + $\nabla\Lambda$, where Λ is a scalar function and $\nabla\Lambda$ is its gradient. The **B** field is given by **B** = ∇ x **A**, so that the new **B'** field becomes

$$\mathbf{B'} = \nabla x(\mathbf{A} + \nabla\Lambda) = \nabla x\mathbf{A} + \mathbf{0} = \nabla x\mathbf{A} = \mathbf{B} \qquad [3]$$

In other words, the **B** field has remained entirely unchanged, even though the magnetic vector potential has been asymmetrically changed. However, if no other change were made, then the electric field **E** would have still been changed because of the gradient $\nabla\Lambda$. In that case the net change would be asymmetrical, because one obtained a "free" **E**-field which could then do work on the system — either beneficially or detrimentally, depending upon the specific conditions, geometry, and timing. To prevent this excess "free" **E**-field from appearing, the electrodynamicists also simultaneously and asymmetrically regauge (transform) the scalar potential Φ so as to offset the **E**-field change due to the regauging of equation [3]. In short, they also change Φ to Φ', where

$$\Phi' = \Phi - \frac{1}{c}\frac{\partial\Lambda}{\partial t} \qquad [4]$$

With that additional change, now both the *net* **E** and **B** fields remain unchanged,[35] even though both potentials have changed and the fundamental stored energy of the system has changed. Unchanged net force fields just mean that only force-free potentials have been utilized to effect the change in potential energy. It also means that the net summation of the two *individually asymmetrical* regaugings has been *symmetrical*.[36]

Jackson points out that, conventionally, a set of potentials (**A**, Φ) is habitually and *arbitrarily* chosen by the electrodynamicists such that

$$\nabla\cdot\mathbf{A} + \frac{1}{c}\frac{\partial\Phi}{\partial t} = 0 \qquad [5]$$

This *net symmetrical* regauging operation successfully separates the variables, so that two inhomogeneous wave equations result that now yield new Maxwell's equations as follows:

$$\nabla^2\Phi - \frac{1}{c^2}\frac{\partial^2\Phi}{\partial t^2} = -4\pi\rho \qquad [6]$$

$$\nabla^2\mathbf{A} - \frac{1}{c^2}\frac{\partial^2\mathbf{A}}{\partial t^2} = -\frac{4\pi}{c}\mathbf{J} \qquad [7]$$

Thus the two previously coupled Maxwell equations [1] and [2] (potential form) have been changed to the form given by equations [6] and [7], to leave two much simpler inhomogeneous wave equations, one for Φ and one for **A**.

Of course this arbitrary *net symmetrical* regauging (net S-regauging) is quite useful for purposes of simplifying the theory and for easing calculations. But its *unquestioning* and rather universal usage has arbitrarily eliminated the freedom of the system designer to *asymmetrically* regauge the system's potentials, and use the resulting excess free force fields to change the kinetic energy in the system without himself performing extra work upon the system. So we advance the condition for violating this symmetrical regauging process as

$$\nabla\cdot\mathbf{A} + \frac{1}{c}\frac{\partial\Phi}{\partial t} \neq 0 \qquad [8]$$

What equation [8] requires is that the two individually asymmetrical regaugings must not be allowed to cancel out each other's freely-produced force fields. Any regauging of the potentials that complies with equation [8] will *a priori* produce one or more excess forces in the system. The *net* regauging will therefore be asymmetrical. By controlling the asymmetrical regauging, the engine designer is then able to control where, how, and when these excess forces appear, and whether or not they are allowed to do work on the system, and whether the work they are allowed to do will enhance the engine's operation or hinder it.

Discussion

Equation [8] has now become the first principle of asymmetrical self-regauging (ASR) for overunity electromagnetic engines and devices. That is, we are now free to A-regauge in a *nonconservative* field manner, where not only do excess potentials appear "for free," but they have gradients so that associated excess force fields also automatically appear for our use in the system. The free force field can drain off the energy in its accompanying free potential's stored energy, and freely perform that much work upon the system.

In applying this asymmetrical regauging approach to overunity, the engine designer is required to pay close attention to the following principles. One should:

(1) Evoke "nonconservative" (asymmetrical) regauging[37] in accord with equation [8].

(2) Have the engine assembly and ancillary subsystems perform this nonconservative A-regauging in some sector or part of its normal operation.

(3) Insure that any "free regauging force" that is produced will — in doing work upon the system and draining away its associated free potential — increase the kinetic energy of the engine.

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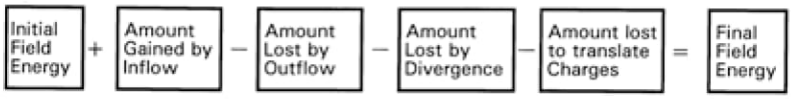

Figure 6. Accounting of Poynting-related energy change.

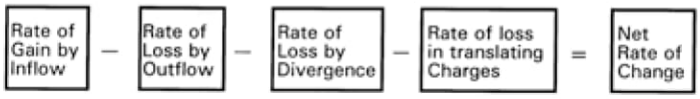

Figure 7. Accounting of Poynting-related rate of change of stored energy.

(4) Insure that, if the "free" regauging forces that are produced would degrade the system operation, they are bottled up and do nothing, thus avoiding their degradation of the system.

(5) If the regauging forces are bottled up, then the excess potential energy from regauging can be utilized with other nearby non-regauging potentials that differ, to provide additional free engine forces to bleed off the excess regauging potential energy to increase the kinetic energy of the system.

(6) Insure that any additional non-regauging forces so produced will either do helpful work on the system to increase its kinetic energy, or they will also be bottled up so they do no work and therefore cannot hinder the system.

(7) Insure that, in consonance with (1) through (6), at least one free force is formed and utilized to expend the pertinent free potential's energy in doing work upon the engine to increase its kinetic energy.

These above seven considerations we now advance as the primary or master principles of asymmetrical self-regauging of electromagnetic engines and devices for permissible overunity efficiency.

Principles (1) and (2) insure that the system opens itself and receives excess potential energy from the vacuum, and that there exists one or more associated forces powered by the excess potential energy, which the engine designer can use to perform "free input work" upon the system to enhance its operation. Principles (3) and (4) insure that the free associated regauging forces will either be helpful or they will be nullified. Principles (5) and (6) insure that other forces formed by potential gradients between the regauging potential and nearby potentials will either be helpful or they will be nullified. Principle (7) insures that *at least one* free force and free potential will be utilized to increase the kinetic energy of the engine.

The electrodynamicists have unwittingly *assumed away* the capability of work-free "self-refueling" of an electromagnetic system directly from the local vacuum,[38] because they have deliberately designed their systems *not to self-evoke and positively utilize asymmetrical self-regauging of the local vacuum potential.* The Maxwellian EM gauge theory model is thus narrowed to an artificially closed (symmetrical) subsystem of equations that utilize a single fixed gauge, and which exclude from their modeling the free opening of the system and free receipt of excess vacuum potential energy with an associated "acting force" fueled by that excess potential energy. *Maxwell's equations themselves do not require this*, and they do allow self-regauging asymmetrically to place the system in disequilibrium so that it freely receives and utilizes excess energy from the surrounding vacuum.

By arbitrary habit, electrodynamicists have discarded the major EM overunity mechanism: *Asymmetrically self-regauging without requiring that external work be done on the system*, in order to freely gather in and collect excess potential energy in the system, with associated excess forces, whereupon that excess collected/stored energy can then be used "drive" the forces to freely power the system and its loads. They have also discarded the major overunity corollary of *regauging asymmetrically so that the normal back-drag or back-emf work — usually done upon the system to reduce its kinetic energy — vanishes or reverses sign and becomes beneficial work done in the opposite sense, to freely increase the energy of the system.*

Self-Powering Electromagnetic Engines

All that is required for "self-powering" EM engines directly powered by the vacuum, is that (1) the engine asymmetrically self-regauge to produce COP>1.0, (2) the seven design principles be followed, and (3) positive feedback (from the output) be utilized to its input, in a clamped and controlled fashion, so that part of the engine's output is utilized to run the engine. The feedback can easily be designed and applied, once the fundamental engine is designed for self-regauging and overunity efficiency. The remaining excess output can then be utilized to power loads, while the engine seemingly "powers itself."

Overunity EM system operation via work-free *asymmetrical* regauging has been inherent in the Heaviside/Maxwell equations for a century, but just conveniently and arbitrarily assumed away by limiting the theory to *net symmetrical* regauging.

There Is an Infinite Set of Nonlinear Maxwell Equations

Since overunity requires violating the conventional classical EM theory, we must further break our mindset from the typical EM engineering analysis usually applied to motors and generators. Most of the EM theory usually applied by engineers is based upon "the" Maxwell equations. However, when nonlinearities are considered, there is not just *one* set of "the" Maxwell equations available, but in fact there is an *infinite* set of them available.[39,40] This alone urges great caution when one is tempted to reach sweeping conclusions based upon "the" Maxwell equations and simple nonlinear EM analysis. Modern nonlinear work with electrodynamics and Maxwell's theory has shown many things that are not normally taught in university courses, and which are not normally part of the repertoire of the electrical power engineer.[41] For overunity purposes, we are directly interested in the classical EM (CEM) model as a gauge theory, and in asymmetrical rather than symmetrical regauging of the model. In fact, we must focus on asymmetric self-regauging (ASR) as the way in which an electromagnetic engine can extract excess energy from the vacuum and expend it to power loads.

Three things normally neglected in the conventional EM analysis are (i) any use of a multivalued potential, (ii) any use of non-conservative fields, and (iii) any use of gauge theory and especially *asymmetrically self-regauging* the stored energy in a subsystem at some point in a rotary cycle. We will briefly cover those areas, but only to the extent of what we need to extract from them for our overunity purposes.

Multivalued Potentials and Regauging

An unusual characteristic that can be achieved in nonlinear electromagnetics and circuits is the involvement of a multivalued potential (MVP) and a corresponding "free" asymmetrical change of gauge of the very vacuum/spacetime in which one is working. That is, in one or more regions of

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the system we can produce automatic "jumps" in the potential energy of the system. If this regauging is also asymmetrical, then excess forces are also produced, which can dissipate the excess free energy to perform work on the rotary system to increase its kinetic energy. This excess kinetic energy then can be easily dissipated in external loads to power them. As stated previously, by convention *gauge transformations*[42] in electromagnetic theory "consist of certain alterations in the values of those [scalar and vector] potentials that do not result in a change of the electric and magnetic fields."

Modern electrodynamicists utilize the standard potentials **A** and ϕ, where **A** is the magnetic vector potential, to represent the electromagnetics in terms of potentials. However, Whittaker has already shown that two *scalar* potentials can be utilized instead, and still produce all the electromagnetics.[44] He specifically points out that this is in contradistinction to the standard (**A**, ϕ) modeling. In short, Whittaker shows that the fields of classical electromagnetics can be replaced by *scalar potential interferometry* of two potentials.[45]

One can symmetrically *regauge* a potential, changing its local value, without necessarily changing the electric and magnetic fields (i.e., without changing the gradients of the potential) in the regauging zone. Or, by asymmetrically regauging, one can change the gradients also. The passage of potential (massless displacement) current $d\phi/dt$ in a circuit, from one isolated loop to another without passage of dq/dt, is a regauging operation, and it is asymmetrical because both an **E**-field and a **B**-field are created in the receiving circuit. The Poynting **S**-flow flows along an equipotential, which is another way of saying that a constant **S**-flow carries a constant orthogonal **E**-field and therefore a constant electrostatic scalar potential ϕ right along with it. It also carries a constant orthogonal **B**-field and therefore a constant magnetostatic scalar potential Φ. If one flows-in excess potential ϕ or Φ, one has flowed-in excess **S**-flow. And vice-versa, if one flows-in excess **S**-flow, one has flowed-in excess potential, usually changing the existing potential gradients (i.e., also changing the forcefields).

In the ideal case, no work is required for regauging, whether or not the force fields are unchanged. Work occurs *subsequently*, after any excess force field performs work and dissipated the regauged excess potential. A multivalued potential asymmetrically regauges the ambient vacuum potential at a multivalue point, establishing free gradients (force fields), and changing the fundamental energy in the system of interest, and thereby permissibly enabling *nonconservative* local fields and *overunity* coefficient of performance. It is very like one of the drawings by Escher, where stair steps descend endlessly because they "close" back via a "regauging" operation upon their starting point, yet are always running downhill.

Regauging by means of scalar potentials only, changes the stored local energy of a system and its local reference potential. That is, at a given "low potential" point or region in a rotary cycle, *a component of the engine can suddenly and freely shift the entire "local vacuum energy" in which that component of the system is embedded*, by means of asymmetrically self-regauging via a multivalued potential. The potential energy of the subsystem freely shifts, and simultaneously provides excess associated forces which can be helpful in using that excess energy to perform work on the engine. In short, the engine *refuels* itself from the vacuum potential.

Pseudo-MVPs and Regauging

In real systems one moves *finite-sized* charges and domains, rather than theoretical "point" charges and point unit north poles, as are conveniently utilized in EM theory. Particularly in magnetics, a multivalued potential can be *emulated* by an ordinary single-valued potential which changes in a very small region with sufficient abruptness.[46] Such an MVP-emulative use of a single-valued potential to accomplish asymmetrical self-regauging is referred to as a *pseudo*-MVP usage. Either real MVP use or pseudo-MVP use in a system means that one can effectively obtain *nonconservative* magnetic fields and cycles in that system.

A system utilizing an MVP or a pseudo-MVP is inherently capable of overunity coefficient of performance, merely by correctly timing the regauging/refueling operation.

The Conservative Field

In Figure 2 we show by analogy a standard conservative field, viewed from the standpoint of the single-valued scalar potential. We have illustrated a circular track on an inclined board, with a ball rolling around the track. Here gravitation furnishes the potential at point A. The rolling ball passes from A to B to C to B' to A to complete one cycle.

From conventional electromagnetic theory, one of the ways of defining a conservative potential field is well-known to be as follows:

$$0 = \int \mathbf{F} \cdot d\mathbf{r} = -\int \nabla\phi \cdot d\mathbf{r} = -\int d\phi \qquad [9]$$

In equation [9] we are referring to the standard line integral of the differential of work about a closed path in a region. Equation [9] specifies that the line integral is independent of the path between any two points P_0 and P_1, and it holds so long as the potential is continuous and single-valued. For most applications this condition is true, and so equation [9] is a fundamental part of conventional electromagnetic theory, motor design, etc.

Equation [9] may also be visualized as the creation of a potential difference at a point A, with reference to point C, whereby energy flows from the potential to the kinetic system during the travel of the rolling ball from point A to point B to point C. That is, potential energy is changed into kinetic energy of the moving ball, with a consequent "drop" in potential of the ball. Subsequently, however, as the ball contin-

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ues from C to B' to A, energy flows back from the kinetic energy of the rolling ball to the system potential. If we wished, we could take energy from the system during the travel of the ball along path A-B-C, but we would then have to do equal work back upon the ball during its travel along path A-B'-C. So here we have a *conservative field*. We simply cannot get an overunity coefficient of performance from this field, no matter what path we take. So equation [9] rigorously holds for Figure 2. Note again the requirement that the potential be continuous and single-valued if equation [9] holds and energy is conserved.

Simply put, equation [9] is usually just written as

$$\oint F \cdot dr = 0 \qquad [10]$$

and, for any system for which equation [10] holds, that system is energy-conservative because the field is energy conservative. Specifically, one cannot get more energy out of such a system than one puts into the system in the first place.[47]

In Figure 2, we can easily see this from the gravitational analogy: Suppose the track and rolling of the ball are drag-free and frictionless. As the ball rolls from A to B to C, it picks up speed and energy because of its "drop" through a difference in potential between point A and C. In other words, it is rolling "down hill," and the gravitational potential is adding the excess kinetic energy. However, as the ball starts back up hill in its travel from C to B' to A, it will steadily lose energy again, passing that energy back to the gravitational potential. It will just barely reach point A in a totally drag-free system.

For a perfect drag-free system, we could give the ball an initial push from point A, and then it would "orbit" around the track forever. Planets in orbit around the sun are in fact in exactly such a condition, at least to first order.[48] However, one could not extract any energy from the ball-track system during its fall along path A-B-C, and have the ball continue to roll around the track. So work is added to the ball from the gravitational potential along path A-B-C, and the ball then does work on the gravitational potential along path C-B'-A.

Such a locally conservative field is no use to us in producing an overunity system.

The Non-Conservative Field

But now see Figure 3. Here we show a track that "spirals downward" all the way from A to B to C to B' to D, and where D is directly under the initial starting point A. The gravitational potential adds energy to the rolling ball all along the path from point A to point D. In the ordinary 3-space, the gravitational potential *remains single-valued* along the line from D to A. Therefore we apply equation [9] or equation [10] and the entire field is still conservative. In short, we would have to do as much work on the ball from D to A as we were able to gain and extract all the way along A-B-C-B'-D. This is a normal conservative field and it will not yield overunity operation.

However, suppose that we are dealing with electromagnetic scalar potentials instead of gravitational potential. Further, suppose that the potential is *multivalued* from D to A. Now a strange phenomenon occurs. When the system has reached "point D" in its cyclic operation from point A, the potential value itself at D suddenly is altered and "regauged" back to its original value at point A. In short, the value of the potential "jumps" all the way back to the initial value of the potential at point A.

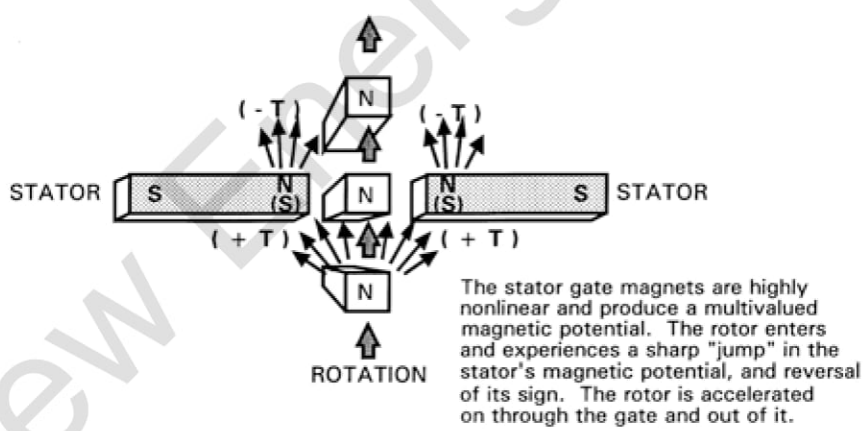
By the gravitational analogy, this would correspond to the ball rolling all the way from point A to point D, and then the vacuum "spacetime" suddenly regauging itself to throw the gravitational potential back up to its initial value at point A. In the physical ball-track analogy, this would also correspond to an external agent suddenly and freely injecting excess energy to *instantly* and *freely* lift the ball from point D to point A.

In that case, so far as we are concerned, we would see the ball just continue rolling always downhill! We could continuously extract energy from it, and we would simply be extracting stored energy from the regauging and refueling by the multivalued potential that had come into being in the region from D to A. We have simply made a *nonconservative field* by use of a multivalued potential to accomplish regauging. Figure 4 shows this "refueling" of an EM engine by MVP ASR.

We accent yet again that no work is required for *perfect* regauging per se, whether the regauging is symmetrical or asymmetrical.

It is possible to make and utilize MVP in electrical machines or in magnetic machines. When we do, we make a nonconservative field in the machine. So we can *permissibly* make an electrical device or a magnetic device that yields overunity electrical performance by ASR. More than a single regauging per rotor rotation can be utilized, depending upon motor design.

To make the so-called "closed-loop" free energy machine, all that is necessary is to (i) utilize a nonconservative field cycle by incorporating a regauging and refueling (resetting) sector of the overunity cycle, and (ii) collect a bit of the excess output energy and use it to run the engine. With proper feedback, either an electrical or magnetic overunity machine utilizing a nonconservative field and timed regauging can "run itself" while simultaneously powering a load.



Effectively a phase conjugation (time reversal) occurs on the exiting edge. The rotor is attracted in; asymmetrical self-regauging occurs. The rotor is accelerated on out. Asymmetrical self-regauging injects free potential energy into the system, from the vacuum. Conservation of energy, the laws of physics, and the laws of non-equilibrium thermodynamics are not violated.

Figure 8. Concept of operation of Johnson's patented magnetic gate.

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Energy Conservation Laws and Thermodynamics Laws are Not Violated

We strongly point out that use of asymmetrical self-regauging to obtain an overunity system *is* permissible, *does not* violate the conservation of energy law, and does not violate the laws of thermodynamics. It *does* violate the arbitrarily symmetrically regauged classical electrodynamics, as do many other electrical things in physics. It is simply a periodically opened system which receives excess input of energy from the energetic vacuum. In short, its use can provide a "freely self-refueling" engine, analogous to a waterwheel in a flowing stream.

The difference between using an MVP and using a pseudo-MVP is straightforward: For the MVP, one must produce and use an actual multivalued potential. For a pseudo-MVP, one makes a single-valued stator sector potential which, though not actually multivalued, is so nonlinear in that finite but very small region, that the finite rotor system traversing the path experiences the potential in that narrow region essentially as if it *were* a true MVP. In other words, a sufficiently nonlinear single-valued potential can change so sharply in a small region that a finite system perceives the change as instantaneous and thereby perceives the potential as multivalued in that region. The Johnson engine applies the pseudo-MVP principle.

Regauging an Electrical Circuit

In a current loop, whenever one stops the current dq/dt in a conductor but continues to pass voltage as displacement current $d\phi/dt$, one continues to pass the Poynting energy flow given by

$$\mathbf{S} = \mathbf{E} \times \mathbf{H} \qquad [11]$$

In short, we pass the flow of potential ϕ (i.e., we pass the voltage) and we therefore change the potential downstream. This *regauges* that part of the circuitry downstream. In one of our patent applications, my colleagues and I described this process as *bridging*. We used bridging to pass the potential from one dq/dt-closed sourcing circuit — where V is large, I is very small, and [VI cos θ] is small — to a second dq/dt-closed circuit where V is large, I is large, and [VI cosθ] is very large.[49] In short, we asymmetrically regauged the potential in the downstream receiving circuit, forming force fields also. That part is work-free flow of excess EM energy into that receiving load circuit. The load is *subsequently* powered by dissipating the regauged potential energy of the load circuit via work performed by the gradients (fields) as they couple to the system and affect it by translation.

Figure 5 diagrammatically shows our bridging approach that simultaneously produces room temperature superconductivity and is theoretically capable of attaining a system COP >1.0. Work in the regauged load circuit does not "cost" us any degradation of the primary source, and it does not degrade the performance of the source furnishing the potential because it does not require load current to pass back through the source. In short, none of the energy extracted *from* the primary source is utilized to perform work *on* the source by driving spent load conduction electrons back through the source against its back emf. Thus no work is done to destroy the separation of charges in the primary source.[51]

We now briefly review the background of Poynting theory. Then we show that Poynting **S**-flow with its corresponding potential flow $d\phi/dt$ (massless displacement current) can yield overunity coefficient of performance in a system wherein a dq/dt-blocked sourcing current loop bridges its **S**-flow, $d\phi/dt$, and emf to a receiving load loop, where the load loop and the sourcing loop are dq/dt-isolated.

Background of the Conventional Poynting Theory

Poynting and Heaviside developed the energy-flow theory[52] in EM in parallel, after Maxwell was already dead. Energy-flow does not explicitly appear anywhere in Maxwellís publications; the *notion* that energy flowed through space was exceeding novel to physicists when developed by Heaviside and Poynting. Circuitry analysis utilizing amperage and voltage were already long established before the notion of energy flow through space was created by the two scientists.[53,54]

We caution the reader that modern theoreticians are still somewhat confused when attempting to apply the Poynting energy flow to electrical *circuitry*, and have only done incomplete work in that respect. They have debated the issue for a century. As an example, many engineers believe that the only energy flow in a circuit is by the Slepian[55] vector $\mathbf{j}\phi$.[56] They do not realize that $\mathbf{j}\phi$ represents the energy flow density that is *collected* by the conduction electrons *in* the wire, from the **S** = **E** x **H** Poynting flow *outside* the wire, and then sluggishly transported by the potentialized conduction electrons at electron drift velocity. Nominally, $\mathbf{j}\phi$ collects only about 10^{-13} of the **S**-flow, for subsequent dissipation in the circuitry to power loads and losses.

In short, modern power engineers usually *do not* track the energy flow in an electrical circuit, but only the power and work flow. One very real problem is that power engineers use the term "power" quite differently from physicists, and in two quite contradictory ways. The engineers use "power" to mean the rate of flow of energy that is not dissipating or diverging (i.e., for pure energy transport) and also for the rate of dissipation of the energy. In physics power is rigorously the rate of performing work, which is the rate of *dissipating* or *converting the form* of the energy. Power engineers thus use "power" as an oxymoron. Further, most leading EM texts give Poynting vector application to circuits a very short shift, then leave it without further ado. They do cover radiation of energy into space quite well, however.

Adapting the Poynting Loss Equation for a Special Form of Superconductivity

Let us examine the conventional Poynting energy loss equation. In classical EM energy flow through a unit volume, the Poynting vector **S** = **E**x **H** represents the amount of EM energy crossing a unit area in unit time, normal to the flow direction of **S**. A positive value represents EM energy flowing out of the unit volume through unit area, while a negative value represents EM energy entering into the unit volume through unit area. [We will later reverse that tradition]. For a medium that is linear in its electric and magnetic properties, the Poynting theorem[58] states that

$$\mathrm{div}(\mathbf{S}+\mathbf{S}') + \frac{1}{8\pi}\frac{\partial}{\partial t}(B^2+E^2) + c\mathbf{E}(i+i') = 0 \qquad [12]$$

where $S=(c/4\pi)(\mathbf{E}\times\mathbf{B})$ is the Poynting vector, and **S'** is any vector field whose divergence vanishes; div(**S**) is the rate at which the stored field energy is diminishing in the unit volume in question due to a net outward flow of energy;

$$\frac{1}{8\pi}\frac{\partial}{\partial t}(B^2+E^2)$$

is the rate at which the amount of stored field energy in the unit volume is changing, and the expression c**E**(i+i') is the rate at which the electric field does work on all the moving charges, in unit volume, losing energy at that rate. Further, *i* represents the ordinary gross macroscopic conduction current while *i'* represents the net microscopic current (within the molecules or within the atoms).

In the theoretical case, EM energy which flows along (outside) a wire as **S**, in an *open* (i.e., dq/dt-blocked) electric circuit, is just such a divergence-free field. If we utilize a multivalued potential, then in the multivalued "jump" region there is just a sudden injection of excess **S**-flow due to the injection of a different equipotential. Consequently an ìopen circuitî — i.e., *one in which the current dq/dt is blocked* — may still pass Poynting EM energy since all the ìenergy density lowî in a circuit exists in the flow of voltage (potential),[59] and voltage and **S** may flow without con-

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comitant current. The fact that the EM energy flowing ìinî an electrical circuit does not flow *through* the wire, but *outside* it, is disturbing to many electrodynamicists even today. [60] The wire serves as a sort of waveguide or railroad track for the energy flow outside. Obviously, if we block the current dq/dt in the wire, we shall block the *expenditure of EM energy as work, from its usual jϕ transporter/carrier*, in that blocked current loop. However, we can still pass the Poynting **S**-vector flow, and therefore we can still pass EM energy without any dissipation of it in that current loop. Since no work is being performed in the current loop, no work is being done inside the source to destroy it. From this sourcing loop, we can then "bridge" across dq/dt-blocked conductors to a separate receiving loop containing the load.

Bridging provides a special form of room temperature superconductivity where the energy flows by massless energy transport, rather than as **j**ϕ. It has an additional advantage of enabling overunity efficiency.

Any Dipole is Already a Source of Free Energy Extracted from the Vacuum

As we previously stated, it is already shown in particle physics that any electric charge is an asymmetry in the violent energy exchange between the vacuum and the charge. Every charge is therefore either a source or a sink. Any dipole is automatically a source on one end and a sink on the other, freely extracting and gating excess energy from the vacuum. This is true for both an electric dipole and a magnetic dipole.

To build a free energy EM source, we do not have to *discover* how to extract and gate excess energy from the vacuum. Every source we have ever built is already doing just that. We only have to discover how to cease using half the extracted energy of a dipolar source, to do work on the internal separation of charges that makes the dipole itself. In other words, we only need to cease "killing" our free energy sources.

dq/dt-Blocking Enables Free Extraction and Use of Energy from the Vacuum

We now advance some background and a theoretical scheme for asymmetrical regauging of a closed loop load circuit by bridging **S**, dϕ/dt, and emf across a dq/dt-blocked pair of conductors from a dq/dt-blocked sourcing circuit optimized primarily for voltage. No ordinary current dq/dt flows across the bridge in either direction.

The very notion of a dipole already implies dq/dt blocking. In one sense a fixed dipole is a charge-saturated capacitor. That is, even though the two charges are attracting each other, they are not moving together, and there is a potential difference across them. This produces a continuing bidirectional exchange flow of EM energy with every other point in the universe, as Whittaker showed in 1903.

Also, contrary to present electrodynamics practice, a scalar potential — simple electrostatic voltage — is *not at all* "a static thing" in and of itself. Its *magnitude* at a fixed point is scalar, and the potential is "static" in that it is not changing magnitude! However, internally that "static" potential is comprised of bidirectional EM waves, arranged in precisely coupled pairs, as shown by Whittaker in 1903. If voltage truly were "static," it could never flow along a wire.

A smoothly flowing river may have a static depth magnitude corresponding to any given point on its surface, and the set of those scalar magnitudes is a scalar field. It may also have a static pressure magnitude at any interior point of the river, and that set of scalar magnitudes is also a scalar field. However, no one would suggest that the *river itself* was static. And no one would be astonished that two such rivers could meet, and their internal dynamic structures interfere so that strong wave changes on the surface occurred in the interference zone. No one would state that such "scalar interferometry" was an oxymoron, or that surface waves could not be produced at a distance by those two rivers, which until the interference zone *had* no surface waves.

The scalar field representing the spatial magnitudes of the potential *is not the potential itself*! It is just one *attribute* of the potential. A static magnitude of the potential at each and every point it occupies, does not tell one anything at all as to *what the potential itself actually is, or what its hidden internal structure is doing*. In the wave view, the scalar potential is a harmonic set of hidden bidirectional wave pairs, as shown by Stoney[61] and Whittaker.[62] In the particle view, the scalar potential is an ordering in the virtual photon flux of the energetic quantum mechanical vacuum.[63]

Because of its hidden dynamic composition, the electrostatic scalar voltage will "flow" from the charged ends of a dipole if we extend the point charges at the ends to line charges; i.e., if we simply "morph and stretch out" the end charges. If the resulting *circuit* is open, the voltage will still flow to the new ends, even though (for ideal conductors) no current dq/dt flows. And we already know from Poynting theory that a real flow of EM energy of form **S** = **E** x **H** continually flows along the conductors.

The primary electrical power source (i.e., the dipole) is *not* dissipated whenever only loss-free field energy density **S** is extracted from it. Any source of potential is *a priori* a free source of EM field energy density — the open-circuit potential and the S flows ìfor freeî and at no dissipation to the source. The energy is extracted from the vacuum and flows along the blocked (ìopenî) circuit wires as lossless flow of potential onto collectors (such as electron capacitors). Applying this potential to trapped charges in a "saturated-charge" capacitive collector allows energy to be freely extracted from the vacuum by the source, and furnished to the collector as excess field energy on the blocked electrical charges of the collector.

So here we have extracted another principle: When the dq/dt current is blocked in a conductor, the conductor will still pass **S**-flow and the flow of potential.

With dq/dt blocked, if voltage (potential) is varied across a coil, normal magnetic field **B** is created in the coil by the changing **E**-field. Energy is thus stored in the coil in the form of ordinary **B**-field.[64] It does not require moving charges dq/dt to create a magnetic field. *As is well-known, in the vacuum the magnetic field is continually created by the varying **E**-field, and there are no observable charges q present nor is there any dq/dt present.*.[65,66]

Further, if the storage coil is the primary of a transformer, a correspondingly induced alternating **B**-field is created in the secondary in normal fashion as the **B**-field in the primary is produced in AC fashion. In short, *field energy density* flows from the vacuum through the charge-blocked primary and across to the secondary without work.[67] In the external circuit on the secondary side, charges need not be blocked. In that case the excess field energy density and emf cumulated in the secondary *couples* to the conduction electrons in the secondary circuit. In the secondary closed current loop, the coupling-in (shuttling in) of excess voltage and emf activates the circuit, and drives electrons around the secondary current loop, passing through the load and powering it in normal fashion.[68] None of this load discharge current passes back through the original source; hence no dissipation of the source occurs, even though the load is powered. So the charge-blocked and energy-shuttling system in this case has become a continuous ìfree powerî system, powering a load without exhausting the primary power source.

In this way, in theory the source will power a load indefinitely. Energy is conserved, but not work. There is no law of physics that requires <u>*work*</u> to be conserved! The laws of physics and thermodynamics are not violated. This is an <u>*open*</u> system, receiving and extracting energy from a recognized source (the virtual photon flux of the quantum mechanical vacuum).[69] The continual bidirectional virtual energy exchange between the vacuum and charged particles in the dipolar separation of charges in the electrical power source provides a continual inflow and outflow of vacuum energy.[70]

By dq/dt-blocking in the external circuit, this exchange energy flux (potential) is gated by the circuit wiring (ìwaveguidesî) and moved down the circuit without any work being done in the source antenna to dissipate its separation of charges. In the

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external circuit the energy density is collected as a finite amount of excess energy in a finite collector such as a coil, or a capacitor whose dielectric cannot undergo additional strain.[71] By switching the capacitive collector or by inductive transformer coupling, the collected free energy is shuttled to a separate circuit and regauges that receiving circuit. The excess energy now stored in the regauged receiving circuit is then discharged normally in the load. In either case the ìenergy collectionî circuit and the ìload dischargeî circuit are in separate, isolated current loops. The result is a legitimate open system capable of overunity coefficient of performance (COP), comparable to a heat pump.

Adaptation of the Poynting Theory for dq/dt-Blocked Conducting Circuits

We now examine the Poynting flow when operating a circuit in a charge-blocking fashion. We start by examining the standard Poynting theory for loss of field energy stored in a unit volume, as repeated in equation [13] below.

$$\mathrm{div}(S + S') + \frac{1}{8\pi}\frac{\partial}{\partial t}(B^2 + E^2) + cE(i + i') = 0 \quad [13]$$

The Poynting theory of equation [13] addresses the loss of EM field energy from a unit volume. It states that the field energy in a unit volume of interest can be lost by three methods, as previously explained. The three loss terms in equation [13] do not *overtly* allow a flow of energy into the unit volume, except by the divergence loss term becoming negative and hence a convergence, the field energy loss term becoming negative and hence an inflow, and the work term for translation of charged particles becoming negative, in which case the particles are giving up field energy to the volume.

So as far as electrical circuits are concerned, the standard Poynting equation is an awkward expression, primarily adapted to deal only with energy flow out of unit volume and through unit area thereof. However, this shortcoming can be remedied by rewriting the terms so that all expressions deal both with field energy loss and field energy gain. For clarity, we use the following word equation shown in Figure 6 for a change in the field energy stored in a unit volume:

Figure 6 shows the word equation used to set up the necessary mathematical relationships. One simply starts with an initial amount of field energy in the unit volume, then adds all gains and subtracts all losses, to arrive at the final field energy stored in the unit volume. By definition, we take the convention that the algebraic sign of gains is positive, and the sign of losses is negative.

Figure 7 shows the word equation used to set up the necessary *rates* of gains or losses of field energy in a unit volume. By integrating each term over a definite time t, that term becomes an amount of change after that time t has elapsed. By then adding the initial EM energy, the final remaining amount of energy in the unit volume can be ascertained as was shown in Figure 6.

We take the initial field energy stored in the unit volume of interest as

$$\frac{1}{8\pi}(B_0^2 + E_0^2) \quad [14]$$

where the subscript zero means *initial.* We take the amount remaining after the change as

$$\frac{1}{8\pi}(B_f^2 + E_f^2) \quad [15]$$

where the subscript *f* means final. The amount gained by inflow is the time integral of the instantaneous rate of inflow, or

$$\int_t \frac{1}{8\pi}(B_{in}^2 + E_{in}^2) \quad [16]$$

The amount lost by outflow is the time integral of the instantaneous rate of outflow, or

$$\int_t \frac{1}{8\pi}(B_{out}^2 + E_{out}^2) \quad [17]$$

We shall assume there is no field divergence loss, since the circuitry wires act as waveguides and *energy transport flow* is confined to the waveguides. The loss in performing work to translate conduction charges is given by the time integral of the instantaneous rate of loss for conduction charge translation, which is

$$\int_t cE \cdot (i + i') \quad [18]$$

Note that, if we do not consider the internal atomic or molecular charge movement, this reduces to

$$\int_t^T cE \cdot i$$

Further, if we block the charge flow i, the remainder of the term reduces to zero.

So with charge-blocking, the instantaneous rate of change of the field energy stored in the unit volume is just

$$\frac{1}{8\pi}\frac{\partial}{\partial t}(B^2 + E^2) = \frac{1}{8\pi}\frac{\partial}{\partial t}(B_{in}^2 + E_{in}^2) - \frac{1}{8\pi}\frac{\partial}{\partial t}(B_{out}^2 + E_{out}^2) \quad [19]$$

In other words, the situation has reduced to pure energy transport without loss.[72] Also, among other things this immediately proves that use of dq/dt-blocking accomplishes regauging of the downstream receiving circuit.

We note that the two terms on the right side of equation [19] need not be equal. If the rightmost term is largest, then the stored energy is discharging. If the leftmost term on the right side of equation [19] is the larger, then the stored energy is increasing.

When we regauge the system by injection of excess potential energy, then the leftmost term on the right side of equation [10] is much larger, and the stored energy of the system is rapidly increased. Integrated over the very small but finite "jump" time dt, equation [19] then gives the total regauging energy freely added to the system.

We further point out that equation [19] applies to either an electrical device or a magnetic device, or a combination. If the current-free field energy is being stored in an inductive collector, the **B**-field increase is significant. If the current-free field energy is being stored in a capacitive collector, the **E**-field increase is significant.

dq/dt-Blocking as Asymmetrical Self-Regauging

With dq/dt-blocking, one may conduct work-free energy flow along electrical circuits without losses. This energy flow is in the form of $d\phi/dt$, or simply put, dV/dt. It automatically involves **S**-flow and regauging of the receiving circuitry. It is directly comparable to the flow of open-circuit voltage down an ideal transmission line with an open circuit. From the standpoint of gauge field theory, it also involves a change of gauge in the receiving parts of the system, as we stated previously.

What is actually being ìconductedî is the change in the *rate of virtual photon exchange* between the vacuum and charged particles. If the charges q do not translate (i.e., if their longitudinal movements are blocked), then $\nabla\phi$ (with respect to ground reference) is built up on each of them. That is, each of them is potentialized to the new potential. In this manner the energy coming from the vacuum exchange may be captured and stored on trapped/blocked charges q as excess **E**-fields between the potentialized charges and the ground line, and hence as excess field energy. This is a capacitive-type storage. Taking *only voltage* from the power source does not diminish its ability to continue to furnish such voltage. Adding this voltage V to trapped charges q produces an energy storage on those charges of Vq. The collector with its stored energy may then be switched out of the collection circuit and across a load, where it is discharged normally through the load in a separate circuit. The collector can then be switched back to the blocking/collection circuit to collect additional free energy. Obviously this modality allows overunity COP.

The Johnson Force-Producing Magnetic Gate

Johnson's patented force-producing magnetic stator gate utilizes a pseudo-MVP created by a complex nonlinear assembly of permanent magnets. When the rotor polepiece enters the stator gate in attractive mode, it undergoes an asymmet-

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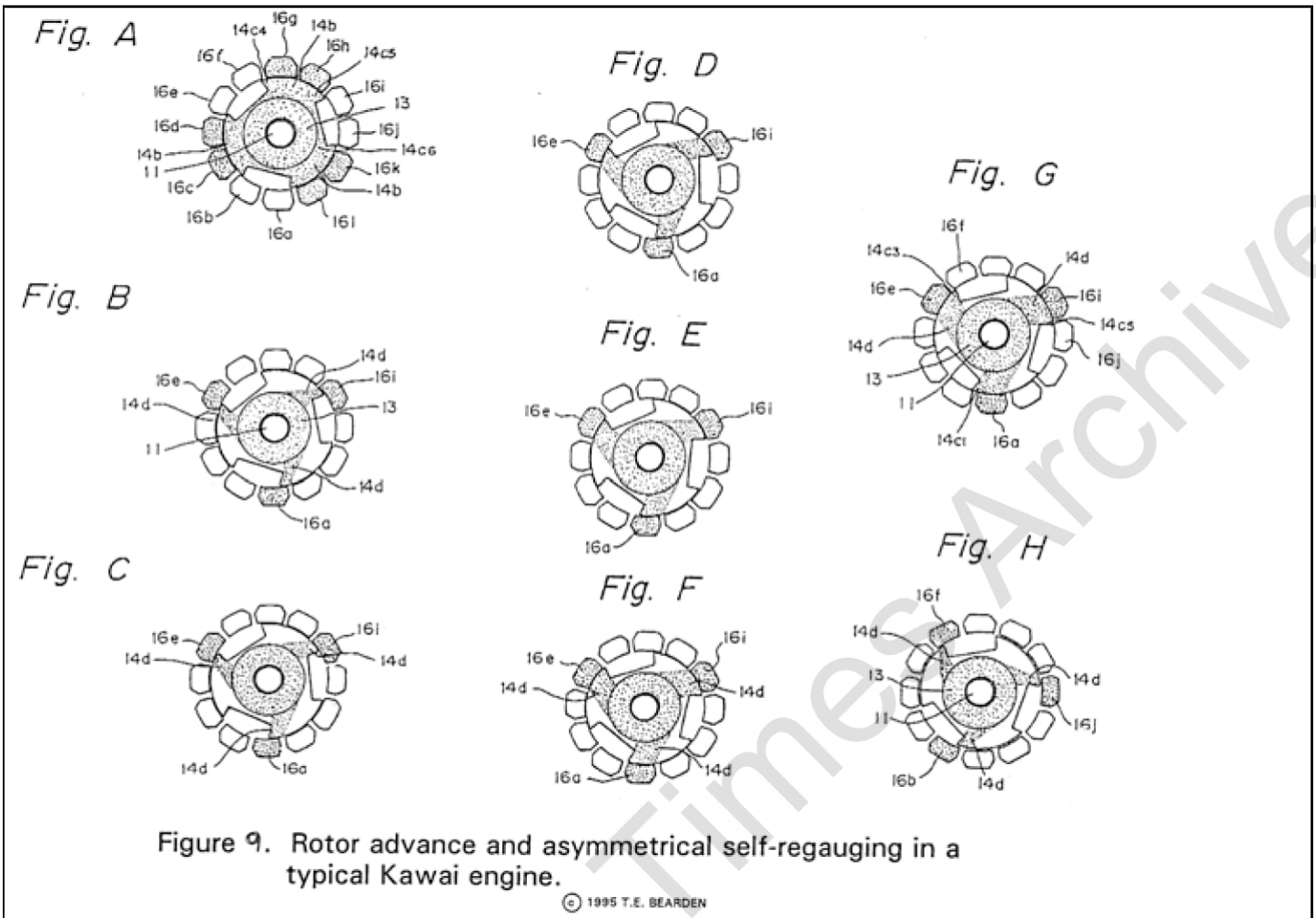

Figure 9. Rotor advance and asymmetrical self-regauging in a typical Kawai engine.

rical self-regauging operation upon encountering the MVP in the middle of the gate.

Figure 8 diagrammatically illustrates the operation of the force-producing gate in Johnson's permanent magnet motor. As Johnson has shown, by using a pseudo-MVP in his stator gates, an approaching rotor magnet is attracted into a highly nonlinear stator gate region where the MVP is located. When it enters the MVP in the attractive mode, the rotor encounters a sudden dramatic jump in the stator's magnetic scalar potential with a change of polarity. Reversal of the polarity is a *time-reversal* operation, or a phase conjugation operation. In the diagram we have shown the time-reversed aspects.

In turn, this sudden change of magnetic polarity and increase in its magnitude, constitutes an asymmetric self-regauging. This produces both an excess magnetic scalar potential (pole strength) and an associated, sudden, *accelerating* tangential force in the region which would otherwise have been the back-drag region. This accelerating force propels and accelerates the rotor magnet on through the gate and out of it, thus increasing the kinetic energy of the engine. That excess energy can then be taken out as shaft power to power the load.

Rigorous force meter measurements taken at 0.01 second intervals prove that this asymmetric self-regauging by a pseudo-MVP occurs as the rotor passes through Johnson's gate. A representative plot of such force meter measurements is shown as the dotted line in Figure 4.

Johnson thus uses a highly nonlinear magnet assembly of special design to create an MVP in his gate. The MVP produces a "magnetic potential jump" and a reversal of the (otherwise) exiting back-drag on the rotor. In short, Johnson uses an MVP to cause the system to be automatically "refueled" by asymmetric self-regauging, so that it can continue to rotate and power a load. The Johnson engine is thus a self-powering permanent magnet engine utilizing the principles described in the present paper.

The Kawai Engine

Figure 9 shows eight snapshots of the rotor advance of a typical Kawai engine, taken from Kawai's patent.[73] This is one end rotor/stator side of a two rotor device, where a similar rotor/stator device is on the other end of the central shaft 11. In Figure 9A, polepiece 14 has three outward teeth 14b dispersed equally around the circumference, alternated with three notches. An end magnet 13 provides the source of flux passing through the polepiece. With the electromagnets de-energized, their core materials 16c, 16d, 16g, 16h, and 16k, 16l are shown shaded, by flux from central magnet 13 outwards through teeth 14b.

In Figure 9B, electromagnets 16a, 16e, and 16d are energized. The shaded area shows the sharp convergence of the flux from magnet 13 through polepiece 14 and the edge of teeth 14b. Since the electromagnets are magnetized in attracting mode, the rotor will experience a torque tending to widen the flux path from magnet 13 to the activated electromagnets. Thus a clockwise torque exists on the rotor, and it will start to rotate clockwise.[74] Note also that each electromagnet is operating independently of the other two.

As shown in Figures 9C, 9D, 9E, and 9F the rotation of the rotor continues clockwise, widening the connecting flux path to the three activated electromagnets. During this time the torque on the rotor is clockwise.

In Figure 9G, the flux path to the activated electromagnets is fully widened. Also, the leading edges of the three teeth are just beginning to enter the domains of the next electromagnets 16j, 16b, and 16f.. This is getting similar to the original position shown in Figure 9B. Consequently, the electromagnets 16i, 16a, and 16e are deactivated, and electromagnets 16j, 16b, and 16f are activated. Asymmetrically, this self-regauges and resets the engine back

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to the original starting position in Figure 9B. The action cycle begins anew. As can be seen, in each complete rotation of the shaft, each of the three teeth of the rotor will be regauged 12 times. So 36 total regaugings/resetting/refuelings are utilized per shaft rotation.

In each stator coil, at energization a tooth is just entering that coil. Energized in attractive mode with respect to the ring magnet around the shaft, the flux in the polepiece "jumps" from fully widened flux (and small or vanishing radial torque on the rotor) to angled and narrowed flux (with full radial clockwise torque on the rotor). As previously explained, the narrowed flux and its angle exert a clockwise accelerating tangential component of force upon the rotor. Each coil is de-energized prior to beginning to exert radial back emf (which it would do if it remained energized as the trailing edge crossed it and again narrowed the flux path). So the Kawai engine uses normal magnetic attraction to accelerate the rotor for a small distance, then asymmetrically self-regauges to zero attraction to eliminate the back-drag portion of the attractive field. It regauges to zero the back-drag as the "RESET" condition.

For appreciable power and smoothness, the Kawai engine uses an extensive number of asymmetrical self-regaugings per axle rotation, being 36 times on each end, or a total of 72 for the two ends. The forcefield of each coil, accompanying its increased magnetostatic scalar potential, is oriented radially inward, so that radial work cannot be done by the coil on the rotor because the rotor does not translate radially. Advantage is taken of the initial clockwise acceleration force initially produced, and ASR eliminates the counterclockwise drag or "decelerating" force that would be produced without it.

The major benefits of the Kawai arrangement are that (i) a large number of ASRs occurs for a single rotation of the rotor assembly, enabling high power-to-weight ratio, (ii) each electromagnet is energized only when positively contributing to the clockwise torque that drives the rotor, and (iii) each coil is de-energized to RESET the system the drag-free condition during those periods when the coil would otherwise create back-drag (counterclockwise torque) if it remained energized.

So the Kawai engine delivers what it advertises: It dramatically reduces or eliminates the "back drag" from the fields of the stator electromagnets, because there are no fields activated in the electromagnets during the back-drag sectors of rotation. A conservative field cycle is one in which the back-drag is equal to the forward boost. Eliminating the back-drag portion of the cycle is a form of asymmetrical self-regauging. Note that again it was accomplished by a change in the magnetostatic scalar potential, where the potential is reset to zero by the de-energized coil during the back-drag portion of an otherwise conservative cycle. The Kawai engine therefore uses asymmetrical self-regauging and nonconservative fields in order to permissibly achieve overunity operation.

Because of the numerous ASR regaugings and back-drag elimination, this engine definitely can provide a COP>1.0. Placed in an electric vehicle with necessary switching circuitry and ancillary equipment, a properly designed Kawai engine and its derivatives should be capable of starting from a single ordinary battery, then powering the vehicle agilely, powering the accessories, and recharging its own battery — all three simultaneously. And in so doing, it complies with all the laws of physics and thermodynamics.

The Takahashi Engine

See Figure 10 for the principle of the Takahashi engine. In the engine a set of permanent magnets, each at an angle to the various radial lines of the device, comprises a slightly widening spiral stator that is "almost" circular but not quite. A circular rotor is mounted inside this spiral stator. An end gap exists in the stator as shown, so that the stator is not a complete closed ring. The direction of rotation for the rotor is clockwise as shown. For demonstration of the principle, the beginning air gap is 0.1 mm and the ending air gap is 5 mm.

A permanent magnet is mounted along the perimeter of an angular sector of the rotor. It is magnetized, say, with the north pole facing radially outwards, and the south pole facing radially inside. In the stator, the permanent magnet north poles are facing radially in toward the rotor, but at an angle, and the south poles are facing radially outside but at an angle.

Thus *tangentially* the north pole of the rotor is in a nonlinear magnetic field, and it will experience a clockwise force and acceleration from position 1 (where the air gap is the minimum) to position 2 (where the air gap reaches maximum).

If this were all there was to it, the Takahashi engine would not be overunity because the tangential field is conservative. When the rotor crossed the end gap in the stator between point 2 and point 1, very sharp and dynamic braking work would be done back upon the rotor magnet by the field of the stator magnets at point 1. This braking work would precisely equal the amount of dynamic acceleration work that was done in accelerating the rotor magnet from position 1 to position 2. For an absolutely frictionless machine with no losses, the coefficient of performance (COP) would be 1.0. Since any real machine will have at least some friction and drag, the actual COP would be less than 1.0.

Let us now utilize the notion of the magnetostatic scalar potential to examine a new situation in the end gap.

Technically, let us regard a single unit north pole in the rotor, going from position 1 to position 2 (the acceleration cycle, where the engine will deliver shaft horsepower against a load), and then from position 2 to position 1 (where the magnetostatic scalar potential must be regauged to equal or exceed the potential at position 1,

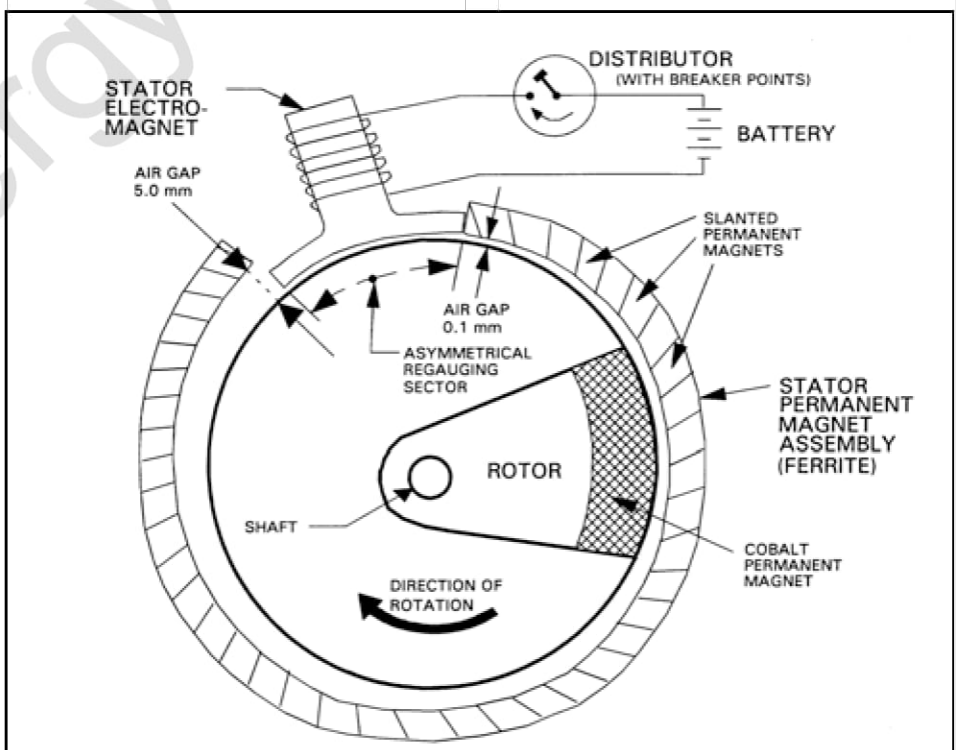

Figure 10. Takahashi Magnetic Engine with Asymmetrical Self-Regauging Section

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in order for the rotor to continue unabated or even further accelerate. I.e., in the separation gap, a regauging operation must be done so that the "stator to inner" potential is increased equal to or exceeding the "stator to inner" potential of position 1. In normal machines, the energy input part of the cycle is always where the design engineer *forcibly* inputs energy from outside the system *to do physical work* on the machine to *forcibly* "reset" its energy storage back to desired initial conditions. In the past engineers have automatically assumed COP<1.0 without exception, since their *forcible* RESET work was itself not 100% efficient, and so it was always equal to or greater than the maximum theoretical energy output to the load during the motor part of the cycle from point 1 to point 2.

To do better than that, the engine must perform the regauging or RESET of the its energy storage, *without performing tangential "drag" work on the rotor*. For that purpose, an electromagnet is utilized to fill the end gap in the stator, arranged so that when it is activated its north pole (and its B-field) will face radially inward. A small current activates the coil weakly, through a distributor with breaker points. At the proper timing (i.e., when the rotor is directly opposite the electromagnet polepiece, the ignition points are sharply broken in the circuit with the coil of the electromagnet. Momentarily, a very high magnetic scalar potential will appear at the end of the electromagnet's coil as the collapsing field is highly amplified in trying to sustain the previous current in its previous direction. The end result is the nearly instantaneous formation of a strong magnetostatic scalar potential (pole), of north polarity, on the stator polepiece facing the rotor. Note that no *radial* work can be done on either the stator polepiece or the rotor by this high potential.

The magnetostatic scalar potential in the end gap is now higher than the potential at position one. Consequently a clockwise tangential **B**-field force exists between the end gap potential and the lower potential at position one. A clockwise tangential force therefore appears upon the rotor, and the rotor is *accelerated* and "boosted" out of the stator gap and back past point 1. Note we are assuming it best to shade the backside of the electromagnet nearest Point 2. This is to reduce a back-drag that would otherwise be created between the increased end gap potential and the potential at Point 2. At that point the electromagnet has lost its potential, but the engine has now been *asymmetrically self-regauged* and now is in the clockwise acceleration field of the rotor-stator permanent magnets.

In short, the rotor perceived the sudden change of magnetostatic scalar potential from the electromagnet in the stator gap as a pseudo-MVP, and the system received a sharp influx of potential energy, with a "free" associated tangential force that can be used to expend the excess potential energy to accelerate the rotor through the regauging zone. To get this, no external work is required to be done on the engine except for that required by the electromagnet's circuitry. Since that energy loss can be made quite nominal by conventional electronic practices, the engine permissibly provides COP>1.0. It can therefore be rigged to power itself and a load simultaneously.

Placed in an electric vehicle with necessary switching circuitry and ancillary equipment, a properly designed Takahashi engine and its derivatives should be capable of starting from a single ordinary battery, then powering the vehicle agilely, powering the accessories, and recharging its own battery — all three simultaneously. It is our understanding that the latest tests of this type engine in an electric motor scooter appears to have demonstrated just these simultaneous capabilities.

There are still some disadvantages with the Takahashi engine. First, the magnets are expensive and would appear to require arduous manufacturing in the asymmetrical configuration shown. The dynamic balancing of the engine would be critical, since the stator is nonsymmetrical and so is the rotor. Also, the single rotor sector would need to be counterbalanced on the shaft, say by another Takahashi stage in counterbalance form. It would be desirable to eliminate these difficulties and also to reduce the rather appreciable costs of such an array of magnets. Nonetheless, the Takahashi engine does appear to be a very viable overunity engine.

Conclusion

In this paper we have briefly discussed the storage and transfer of energy in an electromagnetic circuit from a gauge-theoretic viewpoint. We have presented the multivalued potential and the pseudo-multivalued potential, and their usage in asymmetrically self-regauging the potential in the energy-storing subsystem of an EM engine. Asymmetrical self-regauging (ASR) accomplishes a work-free resetting or "refueling" flow of energy in an electrical circuit, from a modified Poynting vector standpoint, and also provides excess associated forces to utilize that excess energy to do work on the system to increase its kinetic energy. We have discussed embodiments of current-blocking, energy storage, energy shuttling, multivalued potential (MVP), pseudo-MVP, and regauging approach for overunity electrical power systems and for room temperature superconductivity.

In addition we have explained two Japanese overunity engines which have reached or are approaching full production capability in an extremely well-funded, national Japanese strategic effort lasting more than two decades.[75] We have also discussed the "boosting stator gate" and in the Johnson permanent magnet engine, and its use of a pseudo-MVP to accomplish asymmetrical self-regauging; the gate has been rigorously measured to yield excess acceleration of the rotor approaching it, passing through it, and exiting.

Until recently, in model year 1997 a certain percentage of all new automobiles sold in the U.S. would have been required to be *zero-polluting* vehicles — i.e., *electric* vehicles. That deadline has now been temporarily postponed. U.S. automotive manufacturers are already committed for the specific electric vehicles they will be able to offer in 1997 and later. These U.S. offerings will be bulky, cumbersome, largely impractical, expensive, and maintenance-intensive. They will require frequent and lengthy recharging of their huge battery packs. They will give poor performance, get very low mileage (range) between recharges, and will have only austere power for accessory systems. The manufacturers are likely to have to sell them at a loss in order to meet their mandatory quotas, whenever the deadline is restored.

The Japanese manufacturers appear to be readying for production and gradual introduction of a substantial line of electromagnetic engines which are overunity and self-powered, and a substantial line of powerful electric vehicles utilizing those engines. Those vehicles can be initiated from a single battery and will be self-powered from then on. They will be eminently practical, essentially unlimited in range and performance, can be large and luxurious and agile, can have full-powered accessory systems, and could be expected to be available in a wide range of sizes and performances.

It appears that Japan has scored a tremendous advance in the field of overunity engines and power systems. Japanese engineers, scientists, and inventors have attacked the problem of their nation's long-standing lack of energy resources with resolve, patience, dedication, and a sustained financial effort. It now appears that their hard work and perseverance has paid off.

For that reason, this paper has been prepared in order to provide the fundamental principles of overunity operation of electrical circuits and rotary electromagnetic engines. By openly publishing this information, which has taken the author decades to produce, it is hoped that the scientific communities of the United States and other nations will be spurred into competitive development. The processes and principles involved do not require exotic materials or processes. No exotic thermodynamics is involved.

With the imminent introduction of practical overunity engines from the Japanese industries and — hopefully — the industries of other nations as well, it appears

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that the greatest energy, transportation, and industrial revolution in history will now be launched.

FOOTNOTES:

[1]Tom Bearden, "A Direct 'Free Energy' Method," 1980. Internal private personal paper at the time, but long since unrestricted.

[2]T.E. Bearden, "On Rotary Permanent Magnet Motors and 'Free' Energy," *Raum&Zeit*, 1(3), Aug.-Sep. 1989, p. 43-53.

[3]Johnson's original permanent magnet motor patent is "Permanent Magnet Motor," U.S. Patent No. 4,151,431, Apr. 24, 1979. For a later Johnson patent on his magnetic gating processes, see Howard Johnson, "Magnetic Force Generating Method and Apparatus," U.S. Patent No. 4,877,983, Oct. 31, 1989. In his very complex stator field gates, Johnson created a pseudo-multivalued magnetostatic scalar potential. This allowed the rotor magnet to be given a free "propulsion boost" when passing through the stator gate. *Asymmetrical self-regauging* enabled the stator gate to "attract in" the incoming rotor, then strongly accelerate it on through the gate and out of it during exit. Hard measurements made with an excellent force meter at every 100th of a second verify the multivalued potential boost effect. Johnson is presently processing a separate patent application covering this free "acceleration burst" achieved by means of his incorporated pseudo-multivalued potential (MVP). It appears that a variety of electrical and magnetic overunity machines actually and unwittingly obtain their overunity operation from (i) the use of an MVP or pseudo-MVP, and (ii) use of one or more of the application rules for utilizing the MVP — without the inventor being aware of his use or partial use of asymmetrical self-regauging.

[4]T.E. Bearden, "The Final Secret of Free Energy," February 1993, released over InterNet and published in several magazines as well.

[5]Thomas E. Bearden and Stephen L. Patrick, "Method and Apparatus for Extracting Internal EM Flow Energy of the Potential and Reducing Back EMF in Electrical Sources to Improve Operational Efficiency," U.S. Patent Application no. 08/192687, Feb. 7, 1994, and Continuation, May 13, 1994.

[6]T.E. Bearden, Steven L. Patrick, and Kenneth D. Moore, "Room Temperature Superconductivity, Poynting Energy Flow, and Overunity Coefficient of Performance of Electrical Systems." U.S. Patent Application, June 7, 1995. Thomas E. Bearden and Kenneth D. Moore, "Passive and Active Amplification of Input Voltage to Increase Output Field Energy Density of Poynting Generators," Provisional Patent Application, filed July 1995.

[7]T.E. Bearden, "Japanese Overunity Motor and a Commentary," *Explore More!*, Number 13, 1995, p. 37-42. Unfortunately the typesetting process utilized a software translation process from my furnished word processing disk, and it mutilated the mathematical symbology in the published article. The corrected article has now been made available to the magazine's subscribers without charge.

[8]This article was stimulated by a foreign article, "Perpetual Motion Machine," *Guartest*, Sept. 1994. See also a later article by Tony Edwards, "'Accident' in lab creates super motor." *The [London] Sunday Times*, Dec. 10, 1995.

[9]Teruo Kawai, "Motive Power Generating Device," U.S. Patent No. 5,436,518; issued July 25, 1995. Filed June 17, 1993. 16 claims and 19 drawing sheets. Patents cited: 24 U.S., 2 foreign.

[10]Eugene Mallove, "Claimed Over-Unity Magnetic Motor Awarded U.S. Patent: 318% Mechanical Output/Electric Input," *Infinite Energy*, Sept.-Oct. 1995, p. 40.

[11]Eugene Mallove, "Japanese Television Program Reveals Industry-Government Program in Energy from Magnetic Materials," *Infinite Energy*, Mar.-Apr. 1995, p. 48-49.

[12]David Scott, "Magnetic 'Wankel' for Electric Cars," *Popular Science*, June 1979, p. 80-81.

[13]We particularly include the nonlinear thermodynamics of a dissipative system far from thermodynamic equilibrium. A very useful summary of the theory of such systems is given by Gregoire Nicolis, "Physics of far-from-equilibrium systems and self-organization," Chapter 11 in *The New Physics*, edited by Paul Davies, Cambridge University Press, New York, 1989, p. 316-347.

[14]Indeed, any ordinary power system is just such an open system already, at least while being recharged or refueled, and when actually performing work upon the load or suffering losses. E.g., when we add the fuel to a gasoline engine, we introduce "concentrated stored energy" (the fuel) from an external source. So we periodically "open" the system and inject a form of excess energy — the fuel. *While we are adding the fuel*, the system is not only open but also out of equilibrium. In other words, rigorously we *asymmetrically regauge* the system by changing its inherent potential energy. Further, the refueling and regauging operation is accomplished by a negligible amount of work with respect to the energy that can then be dissipated as work. Since we already regauge our normal engines, then it behooves us to extract this "master process" and further develop it.

[15]The reader is referred to any good texts on particle physics. Two excellent, readable references are by Nobelian T.D. Lee, and they are (i) *Symmetries, Asymmetries, and the World of Particles*, University of Washington Press, Seattle, 1988 and (ii) *Particle Physics and Introduction to Field Theory*, Harwood Academic Publishers GmbH, New York, 1981, Second Printing with Corrections, Nov. 1982. Particularly see p. 181-188 and p. 824-828 of the latter reference.

[16]Broken time symmetry and its concomitant violation of local energy conservation was the basis for the overunity mechanism proposed for a Johnson permanent magnet motor in 1989. See Footnote 2 above.

[17]As a case in point well-known in solid state theory, adding energy to Dirac electrons can lift "virtual" electrons from the Dirac sea, into real, observable electrons that "appear from nowhere." Further, broken symmetry is involved in the process *a priori*.

[18]Fundamentally, broken symmetry involves an asymmetrical alteration (regauging) in the local energy density of the vacuum and its structuring. This corresponds to a locally curved spacetime in some aspects. As a special case, use of an MVP allows the local energy of spacetime to be altered in an instantaneous "jump" between two different uncurved states, but adds a local curvature as well since a force is produced. So one can asymmetrically "regauge" the vacuum's local energy in a chosen "reset" sector of an electrodynamic machine, without having to pay the piper. One can have the machine do it itself. Rigorously it need not require work in order to transfer energy to a system, if the energy transfer is done by lossless nonmaterial energy transport, as in regauging. However, once the excess energy is received and stored, it requires an associated EM force field to dissipate the stored energy in the form of accelerating work performed upon the rotary EM engine. Consequently, to use the "freely collected energy" to provide COP>1.0, one must either perform the initial regauging asymmetrically, or if it is symmetrical then it must be followed by an asymmetrical regauging.

[19]We strongly point out that physicists and engineers do not really know *what electric charge is*. The rare physicist will even openly admit it. E.g., see M.P. Silverman, *And Yet It Moves: Strange Systems and Subtle Questions in Physics*, Cambridge University Press, Cambridge, 1993, p. 127. Quoting: "...curiously enough, we do not know exactly what charge is, only what it does. Or, equally significantly, what it does not do." The present author has proposed the rigorous definition $q=\phi m_q$. That definition has profound implications, but these are beyond the scope of the present paper.

[20]Rigorously, the dipole diverges the vacuum flux into two streams of energy. The conductors (transmission lines) connected to the ends of the dipole provide the gating and transmission medium.

[21]I.E., directly from the charge q's virtual photon exchange with the vacuum flux.

[22]Immediately one notices the temporal difference between what is happening overall in the electron shells of the atoms, as compared to what is happening overall in their nuclei. For one thing, a nucleus is on the average *time-reversed*.

[23]To first order an atom can be considered as a dynamic set of such electric dipoles, where each dipole has its negative end as an electron in the electron shells, and its positive end as a positive charge in the nucleus. One thus realizes that the atom is a powerful Poynting generator of very peculiar kind, and intense fluxes of these special and unusual Poynting flows bathe all matter and its vicinity. Further, this "massic energy flux" is internally structured because of the electron shell structuring and dynamics, and the nuclear shell structuring and dynamics, of the "atoms as transmitters and receivers." A novel kind of atomic energy program could be devoted toward directly extracting EM energy from this massic flux by an adapted and extended electromagnetics, without tampering with radioactive residues, huge reactors, and centuries-long pollution and waste disposal problems.

[24]John D. Krauss, *Electromagnetics*, Fourth Edn., McGraw-Hill, New York, 1992. Pages 577-580 cover the applications for Poynting vector to very simple circuits. Figure 12-60, on p. 578 shows Krauss' diagrams for the Poynting power flow in a simple circuit containing a battery and a resistor. The diagrams err, however, in showing the energy flow originating in the battery and ending in the resistor. In fact the energy flow originates in the vacuum surrounding and permeating the battery, flows out through both terminals and along both feeder lines to the resistor, then is scattered back to the vacuum from the resistor. Some of the flow is also scattered back to the vacuum from the internal resistance of the battery itself. Another very useful reference is H.G. Booker, *Energy in Electromagnetism*, Peter Peregrinus LTD, 1982. Part of the IEE Electromagnetic Waves Series 13.

[25]This can be seen as follows: $S = \mathbf{E} \times \mathbf{H}$. There exists an **E**-field between the separated charges of the dipole. Further, the fundamental charged particles of the charges are spinning, and they have magnetic spins and magnetic fields which are aligned perpendicular to the **E**-field. Therefore $\mathbf{E} \times H \neq 0$.

[26]For mathematical proof that any scalar potential is indeed a hidden bidirectional flow of EM energy, see E.T. Whittaker, "On the Partial Differential Equations of Mathematical Physics," *Mathematische Annalen*, Vol. 57, 1903, p. 333-355. Whittaker mathematically decomposes the scalar potential into a bidirectional series of EM wave pairs in a harmonic sequence. Each wavepair consists of the wave and its phase conjugate.

[27]It turns out that we already evoke much greater flows of energy in our circuitry than we are able to collect and utilize, the nominal fraction of collection and usage being about 10^{-13}. Could we collect and use more of it, then a single flashlight battery could drive a battleship. Additional discussion of this interesting phenomenon is given in T.E. Bearden, "Chasing the Wild Dragon: Foundations of a New Science," *The Virtual Times*, Internet node WWW.HSV.COM, November 1995.

[28]Although Ehrenhaft repeatedly reported such. Recently there has been important new work done in this area that indicates magnetic charge, but is not yet definitive. E.g., see V.F. Mikhailov, "Observation of magnetic monopoles in the field of a line conductor." *J. Phys. A: Math. Gen.*, Vol. 18, 1985, p. L903-L906. See also Mikhailov, *J. Phys: Condensed Matter*, Vol. 5, 1993, p. 351-360.

[29]Note that when one says "magnetostatic scalar potential," one has also said "magnetic pole" and "pole strength."

[30]Whenever a potential gradient is applied to a bipolar circuit, a Poynting vector **S** flow of field energy density then flows along the potentialized conductor and a "reference" level of **S** flows along the "ground" side conductor. See John D. Krauss, *Electromagnetics*, Fourth Edn., McGraw-Hill, New York, 1992, Figure 12-60, a and b, p. 578 for good diagrams of the Poynting flow in a simple circuit containing a battery and a resistor. As do all electrodynamicists, however, Krauss errs in showing the flow as originating in the battery and ending in the resistor. In fact the energy flow originates in

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the vacuum surrounding and permeating the battery, converges into the battery dipolarity, flows out through both terminals and along both feeder lines to the resistor, then is scattered back to the vacuum from the resistor. Some of the flow is also scattered back to the vacuum from the internal resistance of the battery itself. The Poynting **S**-flow is outside the conductors, as is well-known, and in the form of field energy flow, via **S** = **E**x**H**, where the conductors act as "guides" or "railroad tracks" for **S**.

[31]See E.T. Whittaker, "On the Partial Differential Equations of Mathematical Physics," *Mathematische Annalen*, Vol. 57, 1903, p. 333-355. Whittaker mathematically decomposes the scalar potential into a hidden bidirectional series of EM wave pairs in a harmonic sequence. Each wavepair consists of the wave and its phase conjugate. Thus any $\Delta\phi$ (as across the terminals of a dipolar electrical power source) *a priori* involves an ordered, hidden, bidirectional EM wave flow. I.e.,$\Delta\phi$ *identically* is such a hidden bidirectional EM energy flow.

[32]It can be shown that normal electrical circuits *nominally* collect as $\mathbf{J}\phi$, and utilize to power the loads and losses, only about 10^{-13} of the actual Poynting energy flow **S** = **E**x **H** that they evoke.

[33]Asymmetrical self-regauging collects just a tiny bit more of the raging **S**-flow that is flowing outside the conductors. E.g., if the self-regauging EM engine collects as $\mathbf{J}\phi$ some 10^{-12} of the **S**-flow instead of the more usual 10^{-13}, it can have a COP = 10. And so on.

[34]J.D. Jackson, *Classical Electro-dynamics*, 2nd Edn., John Wiley & Sons, New York, 1975, p. 220-223.

[35]So-called "canceling" oppositive EM fields are actually produced, which sum to a vector zero which the electrodynamicists discard by assumption. We point out, but do not further pursue, that the locally-produced *field energies* of the oppositive fields remain and add, even though the fields offset each other translationally, since the energy of the field is proportional to its square, and that is always positive regardless of field orientation. Thus "trapped" EM energy has been localized in spacetime in the symmetrical regauging of CEM, and this rigorously is a gravitational change and therefore a local curvature of spacetime *a priori*. The electrodynamicists in their symmetrical neatness have ignored the fact that gauge symmetry electromagnetic transformations are accompanied by local gravitational changes. Heaviside became aware of this type of relationship, and worked out a theory of electrogravitation based on his **S**-flow theory (which added closed-loop circulations of energy which vectorially summed to net zero). Those "trapped EM energy flow loops" were *gravitational*, in Heaviside's theory. His hand-written notes on this theory were found long after his death, beneath the floorboards of his little garret apartment. See H.J. Josephs, "The Heaviside papers found at Paignton in 1957," The *Institution of Electrical Engineers Monograph No. 319*, Jan. 1959, p. 70-76. Nothing further seems to have been done with Heaviside's *testable* draft theory of electrogravitation.

[36]Physicists love symmetry, turn to it at every opportunity, and will do almost any mathematical manipulation to obtain it, because they regard it as "beautiful." And so it is. Performing work, however, requires breaking symmetry to produce a force, and then using that force to do the work. If we wish to build a system that produces more work output than the work that we ourselves have to do upon it to run it, then *a priori* that system must be *asymmetrical* and — to many physicists — *"ugly."*

[37]Many theoreticians object to the inclusion of asymmetrical regauging, preferring to consider any regauging as symmetrical. As we showed, the familiar **S**-regauging is actually comprised of two separate but simultaneous asymmetrical regaugings (A-regaugings). All we need do is (i) break the simultaneity, or (2) break the "canceling" capability of the two A-regaugings, or (3) both.

[38]Again we strongly stress that asymmetrically regauging a potential in the system also regauges the local vacuum potential and the intensity of the vacuum potential's constituent bidirectional EM energy exchange with the system. It directly alters the stored energy of the system. See again Whittaker, 1903, ibid. to see this clearly.

[39]E.g., see G.A. Kotel'nikov, "Toward a nonlinear electrodynamics," *Izvestiya Vuz Fizika*, 38(2), Feb. 1995. The English translation is in *Russian Physics Journal*, 38(2), Aug. 1995, p. 205-208. We point out that exploration of this "infinite set" of Maxwell equations is still in its infancy. Nonetheless its conclusions already can be quite startling to the classically trained engineer.

[40]To see how *really* complex are the actions in motors and generators, the reader is referred to the work of Gabriel Kron, possibly the greatest U.S. nonlinear electrical scientist of all time. Even full general relativity — which Kron rigorously applied to rotating electrical machines — still falls short of what is needed. E.g., the technical reader might wish to peruse his "Four abstract reference frames of an electric network." *IEEE Transactions on Power Apparatus and Systems*, PAS-87(3), Mar. 1968, p. 815-823. Electrical engineers often treat their stationary networks, rotating machines, and microwave electronic devices as a collection of impedance elements Z without decomposing Z into its RLC components. Kron shows that a lumped or distributed impedance network, surrounded by its own electromagnetic field, is actually the sum of four different types of multidimensional networks: (1) the well-studied 1-network of branches in which the currents flow, (2) a 0-network formed by all the point generators, (3) a 2-network of equipotential surfaces that pass through the generators perpendicularly to the branches, and (4) a 3-network composed of three-dimensional impedance blocks surrounding the branches. Thus the topological structure of a stationary or rotating, electric or electronic network is neither a graph nor a polyhedron, but a so-called fiber bundle over a non-Riemannian manifold.

[41]For one thing, the electromagnetics operations one can accomplish are to a large extent dependent upon *the topology of the mathematics in which one's electromagnetics model is embedded*. Normal EM theory utilizes vector or tensor algebra, but many higher topology algebras are in fact available. E.g., normal analysis by vectors and tensors cannot show many of the operations that Tesla actually accomplished in his patented circuits. Yet an analysis of the circuits in quaternion algebra — which is of higher topology than either vector or tensor algebras — will show these functions clearly. For rigorous proof, see T.W. Barrett, "Tesla's Nonlinear Oscillator-Shuttle-Circuit (OSC) Theory," *Annales de la Fondation Louis de Broglie*, 16(1), 1991, p. 23-41. We point out that Barrett is a fine theoretician and one of the pioneers of ultrawideband radar — which does not function by the ordinary "sine wave decomposition" and transform methods of the conventional EM radar theory.

[42]In a general sense, modern gauge theories are an extensive expansion of their parent electromagnetic theory. A particularly good little summary of gauge theories is provided by Benjamin W. Lee, "Gauge Theories," *Encyclopedia of Physics*, eds. Rita G. Lerner and George L. Trigg, Addison Wesley Publishing Company, Reading, MA, 1981, p. 349-351. A useful and slightly more technical summary is given John Taylor, "Gauge theories in particle physics," Chapter 17 of *The New Physics*, edited by Paul Davies, Cambridge University Press, New York, 1989, p. 458-480.

[43]For just a "quick feel," see "Gauge Theory," *Encyclopaedia Britannica*, 15th edition, 1985, Micropaedia vol. 5, p. 147. For a better look, see particularly Article 6.5, "Gauge Transformations, Lorentz Gauge, Coulomb Gauge," in J.D. Jackson, *Classical Electromagnetics*, 2nd Edition, John Wiley & Sons, 1975, p. 220-223.

[44]E.T. Whittaker, "On an Expression of the Electromagnetic Field Due to Electrons by Means of Two Scalar Potential Functions," *Proceedings of the London Mathematical Society*, Series 2, Vol. 1, 1904, p. 367-372.

[45]In 1903 Whittaker also showed that any scalar potential is a special set of multiple EM wavepairs. It follows that the interference of two scalar potentials is just the hidden interference of their biwave internal components. In that manner, *scalar potential interferometry* is not an oxymoron but just a special case of multiwave interferometry, one in which the interfering waves are "infolded" in 3-space and nonobservable, but their interference becomes observable in ordinary 3-space. The practical ramifications of such scalar interferometry are enormous but beyond the scope of this paper. They have been extensively covered by the author elsewhere.

[46]By "sufficient abruptness" we mean that one fundamental "charge" element or "charge grain" — or in the case of a magnet, one single magnetic domain — has a greater diameter than the distance in which the abrupt change or "jump" of potential occurs. For electrical charges this is difficult, but not for magnets. The "back drag" magnetic work experienced by this "real physical charge" of finite magnitude in a magnetic stator/rotor arrangement varies from the theoretical "point-unit north pole value" used in conventional field theory, as rigorously proved by Howard Johnson in actual force and time measurements. One will just get a small back impulse $\int F(t)dt$, over a very short time dt, which means that less retardation work is experienced in the "jump" or regauging region than the work that was obtained from the unit during the rest of the cycle involving the boost.

[47]Note, however, that by regauging we have great latitude as to how we go about inputting the energy utilized by the system in its operation. We are *not* required to use "fields only" and we are *not* required to do work to input the energy!

[48]Because of the multiple bodies involved, a planetary orbit is actually chaotic rather than exactly linearly oscillatory as shown. But the ideal orbit is linearly oscillatory.

[49]Note that energy is conserved from the sourcing circuit to the load circuit, but *work* (energy dissipation) need not be conserved, because we are passing energy from a nearly-free source as pure energy transport, bridged into a separate dq/dt current loop containing the load. Almost all of the work (i.e., dissipation of the energy flow) occurs in the load circuit, not the sourcing circuit.

[50]We point out that voltage is joules per (collecting) coulomb. That is, one volt of potential established from one coulomb of charge q to another reference potential level will result in the *collection* of one joule of excess potential energy upon that coulomb of charge. When we "potentialize" the conducting electrons in a dq/dt-blocked circuit, we freely add real energy to those electrons. Each one corresponds to having been raised from D to A automatically, in Figure 3, as shown by the jump in Figure 4.

[51]This description of course is for the ideal system. In a real system, a very small current must be drawn in the primary source loop. However, this current may be made much smaller than the load current. Also, voltage multipliers can be added in the receiving load loop to increase the load voltage and current, without affecting the primary source current and dissipation.

[52]See any good EM text, in its section on Poynting vector theory. For the original, see J.H. Poynting, ìOn the transfer of energy in the electromagnetic field,î *Philosophical transactions of the Royal Society of London*, Vol. 175, 1884, p. 343.

[53]For a statement of Heavisideís precedence, see Editorial, "The Transfer of Energy," *The Electrician*, Vol. 27, July 10, 1891, p. 270-272. Quoting: "...the idea that energy is located at all, and that, when it changes its position, it must move along a definite path, is quite a new one. The law of the conservation of energy implies that energy cannot disappear from one place without appearing in equal quantity somewhere else; but, although this fact has long been accepted, it is only within the last few years that the idea of transference of energy has been developed, or that anyone has attempted to trace out the actual path along which energy flows when it moves from place to place. The idea of an energy current is of more recent date than the electro-magnetic theory, and is not to be found explicitly stated anywhere in Maxwell's work. We believe that the first time it was applied to electrical theory was in the pages of *The Electrician*, by Mr. Oliver Heaviside, to whom so much of the extension of Maxwell's theory is due. The idea was also independently developed and brought to the notice of the Royal Society in a Paper by Prof. Poynting." As quoted in Nahin, Paul J. (1988) *Oliver Heaviside:*

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Sage in Solitude, p. 117.

[54]Heaviside's theory was actually superior to that of Poynting, because Heaviside included a term which later allowed him to create a theory of electrogravitation. For an article showing what Heavisideís unpublished papers accomplished in this respect, see E.R. Laithwaite, ìMiles Walker — a Pioneer at Met-Vick and UMIST *Electrical Review*, 211(16), Nov. 12, 1982, p. 44-45. To Poyntingís power equation **P** = **E**x **H**, Heaviside added an arbitrary vector **G**, representing a circuital energy flux, to obtain **P** = **E**x H + **G**. Note that Heaviside is correct. In transferring excess Poynting field energy density flow to closed current loops and coupling the field energy density to the conduction charges in that closed current loop, our patent pending Poynting generator circuits provide additional ìtrappedî EM energy that is collected in the receiving current loop prior to its dissipation in the load. It follows that these patent-pending circuits can be *electrogravitational* circuits if so utilized with significant power and in the proper frequency regime (gravitation is very much enhanced at ELF frequencies). As an example, the force existing between two one-coulomb charges separated by one meter distance is about one million tons. So if one is significantly gating the Poynting energy flow in a deterministic manner, one can engineer and gate electrogravitational forces. Obviously the manipulation of local gravity and antigravity becomes a factor in overunity electrical systems when even fractions of such powerful forces are generated. Therefore it should not be surprising that, in addition to overunity operation, the Sweet vacuum triode amplifier operating at 60 Hz was reported to exhibit strong antigravity effects when specially rigged to do so. See Floyd Sweet and T. E. Bearden, "Utilizing Scalar Electromagnetics to Tap Vacuum Energy," *Proceedings of the 26th Intersociety Energy Conversion Engineering Conference (IECEC '91)*, Boston, Massachusetts, 1991, p. 370-375. According to data published by the authors, the machine incrementally lost 90% of its weight when its power output was incrementally raised to 1 kilowatt.

[55]See J. Slepian, "Energy and energy flow in the electromagnetic field." *Journal of Applied Physics*, Vol. 13, 1942, p. 512-518; — — "Energy flow in electric systems — the VI energy flow postulate," *Trans. Amer. Inst. Elect. Engrs.*, Vol. 61, 1942, p. 835-841. Slepian proposed some eight vectors which satisfied Poynting's theorem. For a critique of alternative Poynting vectors, see P.C. Peters, "Objections to an alternate energy flow vector," *American Journal of Physics*, 50(12), Dec. 1982, p. 1165-1168.

[56]As an example, see C.J. Carpenter, C.J., ìElectromagnetic energy and power in terms of charges and potentials instead of fields,î *IEE Proceedings A (Physical Science, Measurement and Instru-mentation, Management and Education)*, (UK), 136A(2), Mar. 1989, p. 55-65. Carpenter advocates replacing the Poynting vector **S** with the Slepian vector **j**ϕ. He does not grasp the difference between the field energy flow evoked by our circuits along the conductors and exterior to them, and the incredibly tiny fraction of that energy that is actually collected as **j**ϕ. He is correct, of course, in stating that **j**ϕ prescribes the energy transport that is actually utilized (dissipated) by the circuit.

[57]As an example of one of the very best of the theorists who does struggle with Poynting flow in circuits, see John D. Kraus, *Electromagnetics*, 4th Edn., McGraw-Hill, 1992, p. 575-580.

[58]See any good electromagnetics textbook or handbook. E.g., see E.U. Condon, ì4. Poynting Theorem,î in ìChapter 1: Electromagnetic Waves,î *Handbook of Physics*, 2nd Edn., Eds. E.U. Condon and Hugh Odishaw, McGraw-Hill, New York, 1967, p. 6-6 to 6-7.

[59]We accent again that a "flow of potential" or "flow of voltage" is automatically a flow of S.

[60]E.g., see Mark A. Heald, ìElectric fields and charges in elementary circuits.î *American Journal of Physics*, 52(6), June 1984, p. 522-526. Quoting: "The charges on the surface of the wire provide two types of electric field. The charges provide the field *inside* the wire that drives the conduction current according to Ohmís law. Simultaneously the charges provide a field *outside* the wire that creates a Poynting flux. By means of this latter field, the charges enable the wire to be a guide (in the sense of a railroad track) for electromagnetic energy flowing in the space around the wire. Intuitively one might prefer the notion that electromagnetic energy is transported by the current, inside the wires. It takes some effort to convince oneself (and oneís students) that this is not the case and that in fact the energy flows in the space *outside* the wire."

[61]Stoney, G. J. (1897) "On a Supposed Proof of a Theorem in Wave-motion, Letter To the Editors, *Philosophical Magazine*, 5(43), 1897, p. 368-373.

[62]Whittaker, 1903, ibid.

[63]Arbitrary elimination of this interior ordering would seem to be where present quantum mechanics seriously errs. Because the scalar potential can be mathematically composed into hidden dynamic order and organization in the *wave* mathematics, then the *particle* mathematics of the interior must also show hidden order. Instead, quantum field theory essentially regards the virtual particles constituting the interior flux as randomly varying, because of the application of Gibbs' thermodynamic statistics. By removing the hidden order, quantum mechanics "loses" the macroscopic world, because integrated randomness is still randomness. This is the reason for the critical foundations problem in QM today: that of the missing chaos (the missing order). Actually the statistics should be changed to chaotic statistics, in which case hidden order is automatically incorporated and the chaos is no longer missing. However, that petrifies most quantum physicists, because it shows that quantum change itself — and therefore physical reality — can be directly engineered, even before the collapse of the wave function and the emergence of the physical change as an observable. Stoney and Whittaker's work is key to that engineering of the "hidden inner EM wave mechanics." I.e., to *engineerable* hidden variable theory.

[64]To drive a primary of a transformer in this fashion, the circuit feeding the excess voltage and emf to the primary must be isolated from the reflected impedance of the transformer. A complete dq/dt blocker, such as the Fogal semiconductor, in the conducting lines accomplishes this insulation from the reflected impedance. In short, one must transfer voltage and emf between two closed current loops, absolutely without the exchange of dq/dt between the loops, and without the reflectance of impedance between them.

[65]The practical difficulty for circuits, however, is that the usual inductive and capacitive time delays vanish or seriously decrease. The formation, collapse, or escape of such a "magnetic field that is unattached to i" occurs at light speed as it does in the vacuum, via free (uncollected) field energy **S**-flow rather than sluggish **J**ϕ *collected energy* flow speeds, whenever the **J**ϕ is blocked. One must therefore utilize *microwave* switching techniques rather than the far slower switching techniques such as usually utilized in motors and generators, which will gain nothing. The rule is this: Coupling of the potential fields to sluggishly moving electrons accounts for the gradual buildup and collapse (i.e., the hysteresis) of inductors. In other words, it is the involvement of **J**ϕ. When the electron movement as dq/dt is blocked, the field energy moves as radiant energy and **S**-flow, hence essentially at the speed of light. There is no **J**ϕ, and hence no hysteresis delay. As may be seen, the use of coils, transformers, and capacitors under dq/dt-blocking conditions is an art unto itself.

[66]Another difficulty in working with dq/dt-blocked circuits is that, in the interior Whittaker structuring of the scalar potential, nonlinear phase conjugate optics effects apply, regardless of frequency. Since potentials extend outward from their source, in a circuit the semiconductors — which are all made of optically active nonlinear materials — thus have a hidden interior Whittaker channel inside the potentials connecting them. Self-targeting (iterative amplified retroreflection) in the interior channel between these semiconductor components easily leads to serious, even explosive, damage to them. Again, this technology is an art unto itself and still largely undeveloped. My colleagues and I are in process of filing another patent in this area, where the difficulties are partially controlled.

[67]Obviously here we are considering an *ideal* transformer. A real transformer will inevitably experience some losses in the transformer itself.

[68]We strongly emphasize that all closed current loops furnish their own conduction charges for their current dq/dt. The source coupled into such a circuit does not furnish a single electron, but only excess voltage and emf. For a simple battery/resistor circuit, e.g., for every electron that is emitted from the positive terminal of the battery into the external circuit, a corresponding (but energetically spent) electron enters the negative terminal. No current dq/dt is actually "drawn from the battery" per se! Instead, the free conduction electrons already in the circuit are *potentialized* by the battery's emf, which drives the electrons through the circuit, including through the loads. The dq/dt acts rather like incompressible fluid flow; for one electron to fall through the entire potential drop in the external circuit from the positive line to the ground return line, a "spent" electron in the ground return line must be forcibly pushed back up through the battery itself, against the batteryís back emf. If one shuttles-in and couples excess voltage and emf to a closed current loop, *regardless of how it is accomplished*, the loop is potentialized and regauged. That loop will thus be "powere" without furnishing current dq/dt to it, and without dissipating the primary source furnishing the excess field energy density (voltage) and emf.

[69]As is well-known in quantum physics, the vacuum is already filled with seething EM energy, and is thus a legitimate energy source. Further, the conventional protest that thermodynamics prohibits extracting and using the vacuum's electrical energy as heat and power is unfounded. Thermodynamics in fact permits just such extraction and usage. For proof, see Daniel C. Cole and Harold E. Puthoff, "Extracting Energy and Heat from the Vacuum," *Physical Review E*, 48(2), Aug. 1993, p. 1562-1565. So one no longer has to prove that the source is there, or that it is <u>*possible*</u> to extract and use the energy. One just has to show how the extraction, gating, collecting, and usage of the vacuum energy is accomplished.

[70]We may also regard this exchange of energy between the vacuum and the bipolarity (potential) of the source to be a wave exchange, as shown by Whittaker, 1903, ibid. Any scalar EM potential can be mathematically decomposed into a harmonic series of EM wavepairs, where each pair consists of an EM wave and its true phase conjugate (time-reversed) replica wave.

[71]E.g., as in a charge-saturated nonlinear ferroelectric capacitor of the 1950s kind. The voltage on such a capacitor can be varied without varying the charge, and the collected energy varies as Vq. In this case there is no dD/dt and there is no dq/dt, but there is dϕ/dt.

[72]Note that an exciting feature of this equation is that, when applied to a static Poynting generator (i.e., crossed static **E**-field and **H**-field, then together with Poynting's vector definition it proves that the static generator produces an unending stream of free energy flow from the vacuum. So any static Poynting generator is also a free energy source. Both a static electric dipole and a static magnetic dipole are such static Poynting generators and therefore free energy sources.

[73]Teruo Kawai, "Motive Power Generating Device," U.S. Patent No. 5,436,518, July 25, 1995. Filed June 17, 1993. 16 claims, 19 drawing sheets.

[74]Note that the patent contains an error, stating at first that the torque and rotation are counterclockwise, then showing it moving correctly clockwise from figure to figure in the series.

[75]In comparison, the Kawai engine is much more symmetrical and straightforward than the Takahashi engine. No costly array of stator magnets is required. The stator need not be a costly spiral buildup. Maintenance, reliability, and reduced cost of production should be much improved as compared to the Takahashi engine.

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Continued from page 30

of these previous original microspheres, being subjected to both a heat and electrical current duty cycle, either flaked, spalled and/or incurred minor cracking of the palladium plate. This inservice deterioration both shortened the useful life of the previously described cell and its efficiency in producing heat.

Still referring to FIG. 2, a non-conducive foraminous nylon mesh 40 is positioned against the other end of these conductive microspheres 36 so as to retain them in the position shown. Adjacent the opposite surface of this nonconductive mesh 40 is a plurality of non-conductive spherical microbeads 42 formed of cross-linked polystyrene and having a uniform diameter of about l.0 mm. Against the other surface of this layer of non-conductive microspheres 42 is a conductive foraminous grid 44 positioned transversely across the housing 14 as shown.

Should the system 10 boil off or otherwise inadvertently lose all liquid electrolyte within the cell 12, a means of preventing system shut-down is preferred which replaces the non-conductive microspheres 42 with non-metallic spherical cation ion exchange polymer conductive microbeads preferably made of cross-linked styrene divinyl benzene which have fully sulfonated surfaces which have been ion exchanged with a lithium salt. This preferred non-metallic conductive microbead structure will thus form a salt bridge between the anode 44 and the conductive micro-spheres 36, the non-conductive mesh 40 having apertures sufficiently large to permit contact between the conductive microspheres 36 and the conductive non-metallic microbeads. The mesh size of mesh 40 is 200-500 micrometers. This preferred embodiment also prevents melting of the replaced nonconductive microbeads 42 while reducing cell resistance during high loading amd normal operation.

The end of the electrode 15 is in electrical contact at 66 with conductive grid 38, while electrode 16 is in electrical contact at 68 with conductive gnd 44 as shown. By this arrangement, when there is no electrolyte within the electrolytic cell 12, no current will flow between the electrodes 15 and 16.

ELECTROLYTE

When the electrolytic cell 12 is filled with a liquid electrolyte 59, current will flow between the electrodes 15 and 16. The preferred formulation for this electrolyte 59 is generally that of a conductive salt in solution with water. The preferred embodiment of water is that of either light water ($H_2{}^1O$) or heavy water and more specifically that of deuterium ($H_2{}^2O$). The purity of all of the electrolyte components is of utmost importance. The water ($H_2{}^lO$) and the deuterium ($H_2{}^2O$) must have a minimum resistance of one megohm with a turbidity of less than 0.2 n.t.u. This turbidity is controlled by ultra membrane filtration. The preferred salt solution is lithium sulfate (Li_2SO_4) in a 2-molar mixture with water and is of chemically pure quality. In general, although a lithium sulfate is preferred, other conductive salts chosen from the group containing boron, aluminum, gallium, and thallium, as well as lithium, may be utilized. The preferred pH or acidity of the electrolyte is 9.0.

CONDUCTIVE BEADS

Palladium coated microspheres were originally preferred as disclosed in U.S. Pat. Nos. '675 and '688. However, palladium may be substituted by other transition metals, rare earths and also uranium. In general, any of these metals which are capable of combining with high volumes of hydrogen to form "metallic hydrides" are acceptable. These metals known to applicant which will serve as a substitute for palladium are lanthanum, praseodymium, cerium, titanium, zirconium, vanadium, tantalum, uranium, hafnium and thorium. Authority for the inclusion of these elements within this group is found in a book entitled *"Inorganic Hydndes,"* by B. L. Shaw, published by Pergammon Press, 1967. However, palladium is the best known and most widely studied metallic hydride and was utilized in my previously referenced patents to form conductive hydrogen absorbing microspheres. In an even more general sense, the broad requirement here is to provide a "metallic hydride" surface, the makeup of the core of the microspheres being a secondary consideration.

ALTERNATE EMBODIMENTS

Referring now to FIGS. 3 and 4, an alternate embodiment of the electrolytic cell 80 is there shown. In this embodiment 80, a non-conductive glass cylindrical housing 82 is again utilized with non-metallic delrin end members 84 and 86: sealably engaged by Gorings 92 and 94 within the ends of housing 82. Inlet and outlet chambers 88 and 90, respectively are fommed into the end members 84 and 86, respectively, end member 84 defining an inlet end, while end member 86 defines an outlet end of the electrolytic cell 80.

A plurality of conductive microspheres 91 formed of a palladium coating over non-metallic beads having a first conductive copper layer and an intermediate nickel layer as previously described are disposed against a concave foraminous conductive grid 96 formed of platinum which is, in: tum, disposed against the inner end of end member 84 as shown. An electrode 16 is in electrical contact with the conductive grid 96 within inlet chamber 88 as shown. A themmocouple 70 monitors the temperature of the electrolyte 89 flowing into inlet chamber 88. These conductive microspheres 91 are loosely packed whereby, when the electrolyte 89 flows in the direction of the arrows through the electrolytic cell 80 as shown in FIG. 3, they raise above.the upright housing 82 so as to be spaced upwardly toward a nonconductive foraminous nylon mesh 98 positioned adjacent the inner end of end member 86. Thus, by controlling the flow rate of the electrolyte 89, the spread or spacing between the conductive microspheres 91 and the degree of movement or agitation is regulated. Although the loose microspheres 91 roll and mix about, electrical contact is maintained therebetween.

A second conductive foraminous platinum grid 100 is positioned between the non-conductive mesh 98 and end member 86 in electrical contact with another electrode 15 at 68. A thermocouple 72 monitors the temperature of the electrolyte 89 as it flows out of the electrolytic cell 80.

As previously described, the end members 84 and 86 are movable toward one another within housing 82 by pressure exerted against plates 50 and 52. This end member movement serves to regulate the volume of the electrolyte 89 within the electrolytic cell 80.

The conductive beads 91 shown in FIG. 4 are shown in their at-rest position during which very little, if any, electrolyte flow is occurring through the electrolytic cell 82.

Referring now to FIGS. 5, 6 and 7, another embodiment of the conductive grids is there shown. A conductive plate 102 formed of silver plated metal having the conductive microspheres 104 and 106 epoxy (non-conductive) bonded at 114 and 116 to the conductive plate 102 is utilized to define the cathode of the electrolytic cell. Thus, the only exposed conductive surface in the cathode is that of the conductive microspheres 104. Nonconductive split polyethylene tubes 108 and 110 extend along the opposing edges of conductive plate 102, around which are wound a plurality of conductive wire bands 112 formed of platinum plated silver wire 0.1 cm in diameter. By this arrangement, the electrolyte may flow along the length of the conductive plate 102 and conductive microspheres 104 to form the necessary electrolytic current flow path between the conductive plate 102 (cathode) and the conductive wire bands 112 (anode), all of the conductive bands 112 being in electrical contact with the positive (+) side of the d.c. power supply (not shown), while the conductive plate 102 being in electrical communication with the negative (-) terminal of that power supply.

EXPERIMENTAL RESULTS/VERIFICATION

Experimental test procedures and results and graphic display of those results from my previous U.S. Pat. Nos. '675 and '688 are repeated by reference thereto. Similar tests with respect to the new multi-layer conductive microspheres were conducted which showed substantially above 100% heat outputs (yields), also referred to as "excess heat". Excess heat is more generally defined herein as the ratio (greater than 1.0) of heat energy output to electrical power input.

Independent verification of my previous experimental procedures and reliability, repeatability and heat output performance of a prototype of one embodiment of my improved system and cell were conducted and reported by Dr. Dennis Cravens, who is currently a professor at Vernon Regional Junior College in physics, chemistry, math and microbiology and Department Chairperson of Math and Science and a consultant to Los Alamos National Laboratory. This testing verification occurred in two separate experimental procedures. The first was conducted at my lab on Feb. 25-26, 1995 on a system and cell which I had previously set up. The second procedure was independently conducted at Dr. Craven's lab where he had complete charge of equipment set-up and operation. The embodiment verified was that of a cell having conductive microspheres of nicked palladium/nickel composition.

The results of this independent verification were reported during a presentation, accompanied by presentation material entitled "Flow Colorimetry and the Patterson Power Cell Design" dated Apr. 10, 1995 at the 5th Annual International Conference on Cold Fusion in Monte-Carlo, Monaco. These presentation materials are attached hereto as Exhibit A.

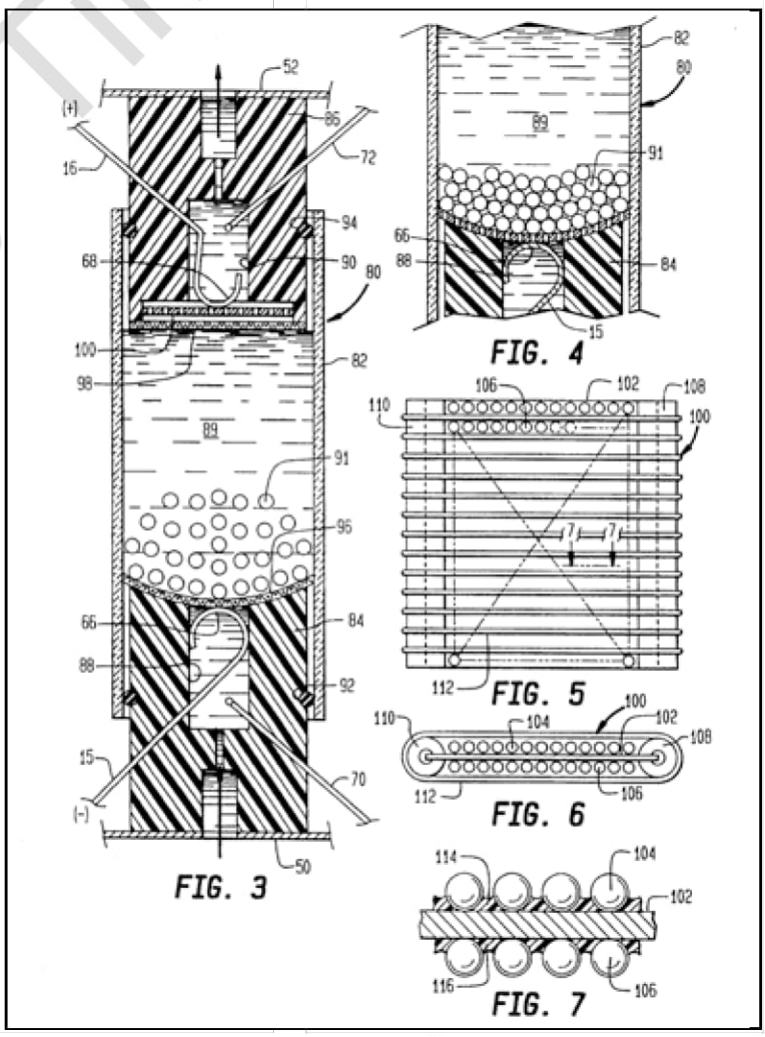
The text describing those experimental verification results was separately reported by Dr. Cravens in a published report entitled "Flowing Electrolyte Calorimetry" dated May 1, 1995 attached hereto as Exhibit B. In Exhibit B. Dr. Cravens reports that, during the I.C.C.F.-5 conference which I attended, this same improved prototype embodiment of my invention (nickel-palladium-nickel plated microspheres) was in continuous operational display producing excess heat. Several conference attenders were witness to this display who actually took data which clearly depicted continuous production of excess heat by the prototype. Table A of Exhibit A summarizes those witnessed results.

Bruce Klein, a recognized authority in this field working for Bechtel Corp., was present and participated in the first verification procedure at my lab with Dr. Cravens. Mr. Klein separately prepared his very favorable written verification report dated Mar. 4, 1995 (not included).

CELL RESISTANCE

In preparing the electrolytic cells for testing, the cell resistance utilizing a Whetstone Bridge was utilized prior to the introduction of the electrolyte into the electrolytic cell. This cell resistance, when dry, should be infinitely high. Otherwise, a short between the anode screen and the cathode beads exists and the unit would have to be repacked. Prior to testing, with electrolyte present, the cell resistance was set at 16 ohms by appropriate compression of the end members. While the instant invention has been shown and described herein in what are conceived to be the most practical and preferred embodiments, it is recognized that departures may be made therefrom within the scope of the invention, which is therefore not to be limited to the details disclosed herein, but is to be afforded the full scope of the claims so as to embrace any and all equivalent apparatus and articles.

[Editor's Note: Section containing Patent Claims Omitted]



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News From Hydrocatalysis Power Corporation

by Jed Rothwell

Dr. Randell Mills, of Hydrocatalysis Power Corporation in Lancaster, Pennsylvania, was first to observe an excess heat or "cold fusion" effect with nickel in light water electrolyte. [1, 2, 3, 4] Others subsequently reported excess heat, notably Patterson and Cravens, [5] and Piantelli [6]. Several workers, notably Shkedi, McDonald et al. at Bose Corporation [7] have reported that nickel appears to produce excess heat, but this is actually chemical recombination. This hypothesis fails explain the results from Mills or Patterson, who have reported energy output 50 to 4,000 times greater than recombination could produce. Recombination cannot begin to explain Piantelli or recent work from Mills with gas loading, where no oxygen is present in the cell, recombination cannot occur, and water formation is never observed. In fact, there is no electrolysis at all.

Hydrocatalysis Power Corporation recently prepared a "Non-Confidential Company Overview" describing its continuing progress in nickel light water cold fusion. Judging from this document, they have made stunning progress. They appear to be the most advanced cold fusion R&D company on earth. They say they have prototype cells that "produce thermal energy immediately, consistently, and continuously." They claim "power densities and temperatures equivalent to those of many fossil-fueled electrical generating powerplants."

Mills has developed an elaborate, unconventional and controversial theory to explain the reaction. He does not think it is a nuclear reaction, but rather (quoting the overview): "a catalytic process, whereby the electron of a hydrogen atom is induced to undergo a transition to a lower electronic energy level than the 'ground state,' as defined by the usual model of the atom." He theory predicts a great deal about how the reaction should work, and what it should produce. For example, he predicts that a nickel cathode will work with potassium carbonate electrolyte, but not sodium carbonate, and he claims experimental proof of this assertion. His theory says the reaction is not nuclear, which is why it produces no significant level of radiation or x-rays. He explains the evidence for helium and tritium by saying that these hydrogen atoms below ground state combine to form "dihydrino molecules" that look like helium even with a high resolution mass spectrometer. These molecules are so small that they occasionally act like muons, triggering a small number of conventional fusion reactions, which explains the low levels of tritium and neutrons sometimes seen in cold fusion experiments. This theory is variously referred to as the "shrunken hydrogen atom" theory or, more formally, fractional quantum energy levels, which sounds like a contradiction of terms to conventional scientists. Most scientists, including most cold fusion scientists, dismiss the theory. If this theory is correct, then the process should release far more energy per unit of mass of fuel than any chemical reaction, but not as much as fission or fusion.

Mills has devoted a lot of research to the theory. It is the focus of much of his experimental work. I have found he is more interested in talking about the theory than the prospects for energy technology. He thinks the theory has broad implications for a wide range of physics, including problems in astronomy like dark matter and the lack of solar neutrinos. He has written a book [8] titled *Unification of Spacetime, the Forces, Matter and Energy* which - as the title says - ties together many loose strings of physics, perhaps even more than Einstein ever hoped to deal with. The title alone is grandiose enough to alienate most scientists.

While I cannot judge the theory, I can evaluate his experimental techniques and calorimetry, and in most cases I think it stands up well, particularly the work he has done in collaboration with Thermacore, Inc., an engineering firm specializing in thermal engineering in military and industrial applications.

These remarkable new claims of success with gas loading have not yet been described in a scientific paper or demonstrated in public [Except for a brief view of apparent gas-reaction aparatus on the BBC/CBC film, "Too Close to the Sun" - Ed.], but their previous claims have been substantiated, replicated, and vouched for by Thermacore and others [such as at Lincoln Laboratory, affiliated with MIT, that prefers to keep its positive results private!-*Ed.*]. Hydrocatalysis says its work has been "corroborated by three leading U.S. research universities; five national laboratories in the U.S. and Canada; and by over half a dozen corporate laboratories in the U.S. and Japan," but they refuse to say which labs. This kind of evasive, overly secretive behavior makes many people suspicious of cold fusion, as do mealy mouthed elocutions like "over half a dozen." They should write "eight corporate laboratories" or 7, 9, 10 or 11, whichever it is. Keeping the names of all these institutions confidential seems excessively secretive, but perhaps the institutions demand secrecy because the field is so controversial. Keeping the number of institutions secret is absurd. Hydro-catalysis claims to be working with several electrical utility companies around the U.S., and they have a scientific advisory board with scientists and engineers from Harvard University, MIT, Pennsylvania State University, and elsewhere.

HPC's near term plans include building a *self sustaining* heater by mid-year 1996, and a 1-kilowatt electric power generator within a year and a half. Unlike many companies and scientists that merely talk about such ambitious plans, Hydrocatalysis has geared up to accomplish this mission, hiring more people and acquiring lab equipment and space. They continue to press for scientific verification of the hydrino theory as it relates to fundamental science in fields like astronomy. They hope the National Radio Astronomy Observatory, in Charlottesville, Virginia, will soon undertake a research project that may reveal evidence for the hydrinos in deep space. Mills [3] claims this evidence has already been found: "hydrogen transitions to electronic energy levels below the n=1 state have been found in the spectral lines of the extreme ultraviolet background of interstellar space." He says this accounts for the "paradox of the identity of dark matter," ubiquitous "diffuse H emission" and other celestial observations.

Hydrocatalysis did not cooperate much in the writing of this article. They did not return our calls or answer technical questions. They go out of their way to avoid publicity. They appeared on television in two documentaries in 1993 and 1994. [9, 10] In the latter they showed the gas loading calorimeters and discussed them briefly, but in general, they have strived to keep their work and the technology confidential. So have most other companies active in this research, including CETI, Fiat, IMRA (Toyota) and most of the big Japanese corporations. I believe HPC's stated policy explains this propensity to keep

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the work secret:

"[Hydrocatalysis Power Corporation's] primary goal in any joint development operation is to obtain revenue from the maximum amount of intellectual property and proprietary know-how developed therefrom."

In other words, their goal is to grab the largest possible share of the emerging intellectual property rights. As new cold fusion technology develops, they want to own as much of it as possible. Many other people in this field, like Jim Reding, CEO of CETI, have made similar statements. They want to control the largest possible chunk of intellectual property. As a businessman, I consider this strategy misguided and naïve. Their goal should be to make the most money, not to grab the most patents. They have forgotten three fundamental facts about business: 1. It is better to have 10% of a billion-dollar market than 80% of a million-dollar market; 2. Some patents are better than others. It is better to have one or two simple, clear-cut, easily defended patents that cover the core of the technology than a dozen disputed, weak patents covering marginal improvements or peripheral technology; 3. Business is a race with the competition, and a race with time.

First generation cold fusion devices will soon become obsolete, just as first generation automobiles, airplanes and computer memory did. A computer textbook published in 1968 lists five different type of random access main memory; only one survived until 1980. [11] Dozens of potentially viable approaches to cold fusion are emerging. One may dominate for a few years, and then disappear as completely as the magnetic core computer memory. In business, the time to make a profit is always *now* - as soon as you are able - not next year, not in five years, because the pace of change, and the surprises waiting around the corner are far too complex for any human being to comprehend. The man who invented the magnetic core memory, the late An Wang, made a great deal of money during the 20-year period these devices were manufactured. If he had waited five years, or if he had gotten greedy and tried to monopolize the emerging intellectual property for different implementations of core memory, like planar cores and microscopic automatically assembled core, some competing form of memory might have taken away the market for computer memory. After all, silicon transistors - which eventually beat core memory - had already been invented when Wang developed the first core memories. If Wang, Ampex and the others had delayed the introduction of core memory while they secretly perfected it and grabbed more intellectual property, transistors or some other emerging technology would have taken over the market instead. If Hydrocatalysis delays the introduction of gas-loaded nickel cold fusion for a few more years, some other form of over unity energy like the Schaeffer / Griggs ultrasound machines, or the E-Quest machine may well emerge and take away their potential market forever.

Footnotes

1. Randell L. Mills and Steven P. Kneizys, "Excess Heat Production by the Electrolysis of an Aqueous Potassium Carbonate Electrolyte and the Implications for Cold Fusion," *Fusion Technology*, August 1991.

2. Randell L. Mills (Mills Technologies, Lancaster, PA), Steven P. Kneizys (Academic Computing, Ursinus College, Collegeville, PA), "Excess Heat Production by the Electrolysis of an Aqueous Potassium Carbonate Electrolyte and the Implications for Cold Fusion," *Fusion Technology*, vol. 20, no. 1, Aug. 1991, pp 65-81, 9 figs. (FF Aug. 1991).

3. Randell L. Mills and William R. Good (HydroCatalysis Power Corp., Lancaster, PA), and Robert M. Schaubach (Thermacore, Inc., Lancaster, PA), "Dihydrino Molecule Identification," *Fusion Technology*, vol, 25, no. 1, Jan. 1994, pp 103-119, 15 refs, 12 figs, 9 tables. (FF Feb. 1994).

4. Randell L. Mills and William R. Good (HydroCatalysis Power Corp., Lancaster, PA), "Fractional Quantum Energy Levels of Hydrogen," *Fusion Technology*, Vol. 28, no 4, Nov. 1995 pp. 1697-1719.

5. D. Cravens, "Flowing Electrolyte Calorimetry," *Infinite Energy*, Vol. 1, Issue #22, p. 18

6. F. Piantelli et el., The Piantelli Patent, *Infinite Energy*, Vol. 1, Issue #4, p. 24.

7. Zvi Shkedi et al. (Bose Corporation, Framingham, MA), "Calorimetry, Excess Heat, and Faraday Efficiency in Ni-H2O Electrolytic Cells," *Fusion Technology*, vol 28, no 4, Nov. 1995, pp. 1720-1731.

8. Randell L. Mills, *Unification of Spacetime, the Forces, Matter and Energy*, Technomics Publishing Company, Lancaster, Pennsylvania (1992).

9. CBC (Canadian Broadcasting Corp.) documentary, "The Secret Life of Cold Fusion," June 1993.

10. BBC and CBC Horizon series "Too Close to the Sun," April 1994.

11. D. H. Sanders, *Computers In Business*, McGraw Hill (1968, 1972) Five primary storage devices are described in chapter 9: magnetic drum, magnetic cores, thin films, plated wire and LSI circuits. Vacuum tube storage is described as obsolete.

The calorimetry sections of the Mills et al *Fusion Technology* papers are well written, honest, and more detailed than most cold fusion papers. They list all components, and they describe procedures in detail, including some weaknesses and blunders, like the fact that in one series of tests "the cell temperature rise above ambient . . . and heater power were recorded daily." [3] This is ridiculous; the temperature should have been monitored by computer and recorded every minute, or at least every hour. However, this is not as bad as it looks:

1. The tests ran for 1 to 11 months, so a large number of data points were taken.

2. The cells were sometimes observed closely for extended periods during each day, although only one point was taken. The thermal mass of the water and metal in the cell is large, with 28 liters of water alone, so changes are very slow. Even if the power was fluctuating rapidly, this gigantic mass would 'smooth out' the signal and show an average value, which would not change for hours. The paper shows a 40 hour sample of data with thousands of points, taken from a smaller cell which had a much faster response time. It has no significant fluctuations.

3. The Delta T rise was large, ranging from 3.7 °C to 12.9 °C, corresponding to excess power ranging from 21.5 up to 75.7 watts. It is impossible to miss such large temperature rises

4. The cells were sometimes watched for long periods during which the Delta T did not change measurably.

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A National Symposium on "Normal Temperature Nuclear Fusion" in China

Reported by Professor Li, Xing Zhong
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On March 2, 1996 there was a national symposium on "normal temperature nuclear fusion" in China. The terminology "Normal Temperature Nuclear Fusion" reflects the Chinese view about the "cold fusion" phenomena. Most of us believe that it is a kind of nuclear fusion reaction, but it happens in the "normal temperature" range. In Chinese language, "Normal Temp-erature" means that it is not high temperature (as high as that in the "hot fusion"); it is not low temperature (as low as that in the cryogenics for low temperature super conductor). There were a series of national symposiums on "cold fusion" phenomena since 1989, but this one had a special task to review the progress of each Chinese group supported by a special fund in the past year. Since 1995 the State Science and Technology Commission, and the Natural Science Foundation in China set up a special fund to support this particular research. Every one knows that if this "cold fusion" phenomenon was true and reproducible, it would alleviate the serious contradiction between the energy sources and the environment in the next century. Nevertheless, everyone knows also that it is very difficult to reproduce this phenomenon for sure. There are a lot of Chinese scientists who do not think there would be any chance for this phenomenon. They did not look at the data any more after November 1989 [Editor's Note: Precisely when the U.S. Dept. of Energy rendered its negative report!], and they veto any proposal on this research. Since the Natural Science Foundation in China operates on the basis of vote, it has been very difficult for "cold fusion" research to win the vote. However, a few judicious senior scientists with high reputation became aware of this situation, and made a suggestion to the Natural Science Foundation in China, and the State Science and Technology Commission. Based on this suggestion a special fund was set up to support this research. Although the funding level is very low, it does help this research survive in China. This March Symposium is just for reviewing the progress after the establishment of this special fund in 1995.

There were about 30 conferees attending this symposium. Among them were the sponsors from the State Science and Technology Commission, and the Natural Science Foundation in China; a few senior scientists; the leaders of each research group; and some participants in each group. About one third of them were young graduate students and post-doctorates. After the key notes speech, nine talks were delivered in the morning session and afternoon session. Each talk was limited to 30 minutes with 5 minutes questioning and answering. In the evening a three hour session was run with full discussion in details. The senior scientists addressed their comments on this symposium as well.

A major feature of this symposium was that the "excess heat" detection appeared almost in every research group. In the past five years, Chinese scientists paid more attention on nuclear signals (the charged particle detection, neutrons, X-ray and Gamma rays). Since we had very little financial support, and we believed at that time that the nuclear signals should be commensurate with the "excess heat;" then, the nuclear methods had higher priority than the calorimetric methods. Gradually, we understand that "Thunder without Lightening" might be the feature of this "cold fusion" phenomenon, and the conventional nuclear signals might not be commensurate with the excess heat. So the calorimetric measurement might be the more suitable technique to identify this phenomenon. The preliminary results showed that there were some features which could be explained as the evidence of the "excess heat" (the urning point in the cooling curve, the sudden change of the temperature, etc.); however, more careful work is necessary before it becomes compelling evidence.

The electrical discharge work has been improved after the Nagoya conference. Although the neutron energy was found to be 2.45 MeV (normal), the yield of neutron was still found to be higher than normal (abnormal). In order to reduce the yield of the normal neutron, a careful study on electrical discharge was done to identify a set of operation parameters with which the abnormal neutron yield become more apparent.

A new set of Si-Li detector was used to refine the X-ray detection. A fine structure of X-ray spectrum was found definitely, and the difference between the discharge in deuterium gas and in hydrogen gas has been identified (the energy and the intensity of the X-ray for Nb-D system was higher than that for Nb-H system).

An interesting "radiation after death" was found after shut down of the electrical glow discharge. It may last as long as 1000 seconds. More careful work should be done before any possible explanation on this phenomenon. But the similarity to "heat after death" surprised all the attendees.

A careful theoretical study were done to analyze the X-ray spectrum. It was found that among the 200 spectra about 100 spectra were abnormal. None of the theoretical fitting could explain the strange features in the X-ray spectrum. It was considered as an evidence of the abnormality in the electrical discharge tube.

A calorimetric measurement was done with the electrical discharge tube. A sudden change of the slope of the cooling curve (temperature versus time) was found in a series of discharge with different electrodes and gases. Ni-H system had been studied with the emphasis on "excess heat"; however, a different conclusion was found. Although the Italian results had been reproduced, different explanations were given to this similar phenomenon. Based on the new explanation, the careful work proved that the "excess heat" in the Ni-H system disappeared.

In some institutions, the research had not reached the final stage to have some new data; but they expected that some new results might be obtained before the ICCF-6. Some institutions presented their plan for improving their previous results. The dynamics on the D-Pd interface were addressed, and the nano-meter material was suggested for future studies. The Ti-D system showed interesting results after analysing the mass spectrum on the titanium surfaces above or

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under the heavy water level in an electrolytic cell. The ionic crystal was suggested for future studies. The new idea to use proportional counter technique in detecting the trace of the charged particles was interesting; and the idea of using pressurized fission reactor technique to run the electroanalytical cell had been realized in a laboratory with particular designing to guarantee the safety.

The gas-loading technique had been studied for more than five years in China in combination with the nuclear signal detection. At this symposium, a preliminary study on "excess heat" in a gas-loading system introduced interesting discussion. Since the "heat after death" phenomenon and other gas-loading experiments in Italy and in India revealed the possibility of observing the excess heat in a gas-loading facility, the advantages being more cost effective, and safer in a gas-loading system became attractive. Besides, it had the feature of accumulating the reaction products in the reaction vessel which might be detected later after a long period of operation. A pair of twin systems had been manufactured to see the difference between the deuterium-palladium system and hydrogen-palladium system. A sharp contrast had been observed already. More results were expected after the consequential operations.

One of the senior theoreticians presented his new results on the mechanism of "cold fusion" after intensive study for more than two years. His unique feature was that he collected the evidences through the careful scrutiny of astronomy and astrophysics. He solved the Schrodinger equation for the three body problem in a better way, and obtained the energy level for the proton-electron-proton system and for the deuteron-electron-deuteron system. He claimed that the 12.5 keV or 25 keV X-ray should be found as an evidence of the energy level in the p-e-p or d-e-d system , respectively. "Thunder without Lightening " was a natural result in his theory, because it was not a nuclear reaction at all. Additional 20 minutes was assigned to him by session chairman to facilitate his presentation because he had more than 46 transparencies to be presented. His enthusiasm in this study was clearly observed by every attendee, although it was very difficult to agree or disagree with his point of view in such a short period. His result was similar to that of professor Baruit of Colorado University, but his derivation was different and more strict in mathematics.

Due to the time limit, not all of results had a chance to be presented at this symposium, such as the preliminary study on sonoluminescence and "cold fusion," and the new theoretical result of resonance tunneling in a crystal lattice, the "self--lock" mechanism in the narrow resonance phenomenon, the comments on the Italian Ni-H system etc. Some preprints were distributed instead of the oral presentations.

The collaboration between institutions, the publication of internal reports in China, and the preparation for the ICCF-6 were discussed in the evening session also. Since additional funding was necessary for those subjects, no real solutions were found yet.

Fourth Russian Conference on Cold Fusion and Nuclear Transmutation

Infinite Energy magazine received this announcement:

•RUSSIAN ACADEMY OF SCIENCE
•RUSSIAN STATE COMMITTEE ON HIGHER EDUCATION
•MOSCOW STATE UNIVERSITY
•RUSSIAN PHYSICAL SOCIETY
•NUCLEAR SOCIETY OF RUSSIA
•RUSSIAN CHEMICAL SOCIETY

At present we are concerned with organizing of the **Fourth Russian Conference on Cold Fusion and Nuclear Transmutation**, which is going take place in a rest-home [Ed note: a resort!] in Sochi (on the shore of the Black Sea) during May 19 - 26 period.

The programme of the Conference includes the following subjects:

1. Experimental researches of Cold Fusion and Nuclear Transmutation with the different scientific methods and instruments;
2. Cold Fusion and Nuclear Transmu-tation theoretical models;
3. Cold Fusion applied technologies and devices.

We are pleased to invite you to participate at this conference and to report on any subject preferred by you. Announce us the title of your report please, if it will be presented. The language of the Conference will be Russian and translation into English will he available. If you want to take part in our Conference you should inform us by fax until March 31 for we will be able to organize your meeting and providing with railway tickets.

The registration fee of $ 1200 for participants covers:

- conference proceedings
- a transportation from airport to Moscow and back;
- a hotel stay in Moscow (one day before and one day after trip to Sochi);
- a transportation by railway from Moscow to Sochi and back;
- a hotel stay in Sochi;
- the daily meal (breakfast, dinner, and supper) during May 16- 29 period;
- the registration fee.

If you pay before March 31, your fee may be reduced up to $ lOOO. In this case we inform you about our account number. We will be ready to meet you from May 16 to noon of May 17 in Moscow if you would give us the information about flight date and number. The projected date of reversed flight from Moscow is May 28-29. Please inform us the number of your E-mail address.

We can propose you to stay some additional days in Moscow after the Conference to see Moscow and suburbs. Also, it's possible to visit St. Petersburg. If it's interesting, please, inform us about Your wishes .

Yury N. Bazhutov, Chairman of the Organizing Committee

Valery P. Koretsky, Vice-Chairman of the Organizing Committee

Phone:(095)464-78-8l, (095)212-04-90 Fax:(095)292-65-11 Box 6935 Erzion

P.O-Box 169, "Erzion" Center, 105077 Moscow, Russia

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• Cars Running on Water Already!

Infinite Energy Magazine received this brochure from the A-55 L.P. company of Reno, Nevada:

A-55 L.P.

The A-55 Limited Partnership is a research and development company founded in 1992 by scientist and President, Rudolf W. Gunnerman, with the goal of developing a less expensive and clean fuel technology. Today, that goal has been achieved through the introduction of the A-55 "water/fuel" Technology. The headquarters of the A-55 Limited Partnership is located on its three-acre research facility in Reno, Nevada.

A-55 Technology

The A-55 Technology encompasses a proprietary water-based fuel, the method for combusting the fuel, and related worldwide patents and patent applications. The A-55 fuel can be used to power all internal combustion engines with major reductions in emissions and no loss of performance. The A-55 fuel is produced by combining up to 55% water by weight with 45% heavy naphtha (a low-cost petroleum product produced early in the petroleum refining process) and a small quantity of a proprietary additive package that enables the water and naphtha to mix into a stable emulsion. The amount of water in the fuel might vary for specialized engine applications. The additive package assures fuel quality including protection against rust and freezing.

A-55 &Advanced Fuels

Understanding that the scope of this technology is too broad and far reaching for the expertise of just one company, A-55 teamed with Caterpillar Inc. in 1994. The joint venture company between A-55 and Caterpillar is called Advanced Fuels. Advanced Fuels owns worldwide rights to further develop and market the technology for both compression-ignited (diesel) and spark-ignited internal combustion engines. Although headquartered at Caterpillar's Engine Division in Mossville, IL, Advanced Fuels relies on strong technical as well as commercial support from A-55 personnel and facilities. Advanced Fuels is marketing the technology under the name A-21 - "Advanced Fuels for the 21 st Century."

A-55 Technology Markets

A-55 is developing and marketing the technology in boiler, home heating, aircraft and other non-internal combustion engine applications. As in the internal combustion engine market these applications are also facing tighter emission regulations. In addition, the A55 team is continuing to develop a more efficient fueling infrastructure and even less expensive fuel resources. Naturally, A-55's core research business continues, and has resulted in several further technology related patent applications.

A-55 Management

The A-55 Limited Partnership is headed by its President and CEO, Rudolf W. Gunnerman. Mr. Gunnerman's past scientific accomplishments have included discovering and securing the basic patents for wood pellets and advanced fireproofing materials. In 1995, Mr. Gunnerman was nominated as a finalist for his work with the A-55 Technology in *Discover Magazine's* International Awards for Technological Innovation. A-55's management includes Mr. Daniel J. Klaich, Senior Vice President, Mr. Peter W. Gunnerman, Vice President - Operations and Mr. Paul Knauff, Chief Financial Officer.

A-55 Technology Overview

The A-55 fuel and related technology can be used in all boiler, turbine, engine and home heating applications .Thousands of hours of on-and off-road demonstrations and testing have proven the technology's compatibility and durability Only minor modifications to these applications are required.

The A-55 fuel is less expensive than both diesel and gasoline. The primary components of the A-55 fuel, water and heavy naphtha are plentiful. Heavy naphtha is approximately one-half the cost of diesel or gasoline at the refinery gate. The automated blending process is accomplished easily within the existing petroleum infrastructure The A-55 fuel can be delivered in petroleum tanker trucks, stored in existing filling station tanks and dispensed through existing pumps.

The A-55 Technology reduces emissions substantially. Internal combustion engines running on the A-55 fuel exceed pollution reduction standards of the year 2004 and beyond. Tests have shown that in spark-ignited engines, oxides of nitrogen (NO_x), hydrocarbons, and carbon monoxide emissions are reduced to levels below those currently being measured on vehicles with catalytic converters. These reductions apply to small engines which are experiencing increased emission regulation by the EPA as well. In diesel engines operating on A-55, NO_x and particulate emissions are reduced 50% - 80%, depending on the carbon/water ratios in the fuel. Equally low emissions are achieved in industrial and power boiler applications. The A-55 Technology reduces the need for expensive and energy-intensive exhaust aftertreatment devices, thereby further increasing boiler efficiency. Also, major cost and pollution savings are possible in the refinery process due to the minimal energy needed to produce naphtha.

A-55 is a primary fuel. Alternative fuels add significant economic burdens to the end user and the production and distribution channels, relegating alternative fuels to limited or niche markets. Higher costs require alternative fuels to be mandsted or supported by governmental agencies. This is not the case with the A-55 fuel. A-55 is the only fuel which holds the promise of breaking this economic cycle by providing not only dramatically reduced emissions but also lower costs to the consumer. As a result, and since the fuel utilizes rather than displaces existing infrastructure, the markets in which the A-55 fuel may be used are very large, consisting of today's entire fuel sector.

A-55 L.P.
210 Gentry Way
Reno, Nevada 89502
(702) 826-8300-Tel. (702) 826-8383- Fax

••End of Brochure••

Editor's Comment: The A-55 fuel has had high-profile news coverage in the U.S. *Business Week* (August 8, 1994, p.47) brought out other key aspects of the technology that may bear relation to "cold fusion" effects. Most important, engines must be modified with small pieces of nickel welded to the insides of the engine combustion chambers-to the crown of the chamber or to the top of the piston. No one knows why this works, but Gunnerman was said by *Business Week* to beleive that "the water gets broken down into hydrogen and oxygen, and the hydrogen contributes energy to the combustion process."

Another indication of an unusual phenomenon at work: The increase in

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miles-per-gallon of fuel efficiency (rated on the fossil fuel part) has been reported to be at least 30%, with unofficial reports of 50% increase or more! To convert a standard automobile engine to the A-55 fuel would require less than $500, the company reports. This would include a fuel-injection control chip to allow use of either ordinary fuel or A-55.

The special fuel has now been certified by the state of Nevada, Division of Environmental Protection. U.S. Federal approval is pending. Multi-billion dollar Caterpillar Corporation has spent millions of dollars helping to develop the fuel. Rita Castle, Caterpillar's issues analysis manager told Tom Gardner of the Associated Press: "As the world's leading producer of diesel engines, we have a commitment and a stake in all fuel options our customers will want to know about. That's why we've engaged this initiative." [Comment in AP story in *Daily Sparks Tribune*, Sparks, Nevada, February 12, 1996, p.2A]

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***Editor's Note*: The following translation document, received from Japan, had many spelling mistakes. Some are corrected, but some abbreviations, odd terminology and peculiar punctuation were left as is.**

1996 NEW HYDROGEN ENERGY SYMPOSIUM
22 - 23 FEB 1996

PLACE: New Sapporo Ark City Hall, (5th Fl, Ark Hall), Sapporo, Japan.

PROGRAM

22 FEB (T): (At Sapporo Elec Center /NHE Laboratory)

1. Registration. (1300)
2. NHE Lab Tour. Data Base Demonstration (1300-1600)
3. Reception (1630-1830)

23 FEB (F): (At New Sapporo Ark City Hall).

1. Explanation of Operation of NEDO /NHE
3. Report of Practical Technology Development

(1). State of Excess Thermo-instrumentation Test of Electrolytic Method.
a). Reproducibility Recognition Test by Fuel Cell type and Open type Electrolytic Cell.
b). Development/Confirmation of Mass Flow Calorimetry System

(2). State of Development and Analysis of Electrode Materials
(a.) R/D for High Occlusion Efficient Materials
(b). Materials Analysis/Observation and Materials Evaluation
(3) Therm in Future and R/D plans

3. Report for Interim Evaluation.

4. Report for Fundamental Rsch Support.

(1). State of Fundamental Rsch support.
(2). Detection of Excess Heat and Measuring Technology Evaluation Electro-chemistry Reaction Group
(3). Correlation of Nuclear Reaction Products and excess heat.
(4). Nuclear Physics approach for to Solution of Nuclear Reaction Mechanism.
(5). Calorimetry of Pd-DH(D) Gp and Electric Resistance Measurement
(6). Material Science effect to Factor of Heavy Hydrogen Occlusion Characteris-tics.

CLOSING DATE: 9 FEB 96 (F) (On a first come first served basis)

ENTRY FEE: 10,000 Yen (Including Reception/Touring)
Limited for Nr. of participants: 150.

POC: Ofc of Symposium Executive Committee, NEDO/IAE
Tel: 03-3508-8901
Fax: 03-3508-8902

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The following is a press release sent to *Infinite Energy* by Marsha Sims, Assistant. Editor, *Journal of Scientific Exploration*:

Former Directors Dispute Conclusions of Government ESP Program Review by CIA

The current issue (Vol. 10, No.1) of the *Journal of Scientific Exploration*, an international peer-reviewed research journal, presents the most complete discussion to date of the 24-year long government-sponsored ESP programs at SRI and SAIC. In addition to the official reports on the program by Prof. Jessica Utts, (University of California, Davis) and Prof Ray Hyman (Univ. of Oregon) the *Journal* is publishing the first in-depth discussions by former program directors Dr. H. E. Puthoff and Dr. Edwin May and by former SRI researcher Russell Targ.

Both Puthoff and Targ discuss, among other things, declassified aspects of the code-named Scanate efforts at SRI to psychically view top secret facilities in the former USSR and elsewhere. They present the first released drawings of the Semipalatinsk, USSR facility comparing the psychically-obtained sketches with satellite reconnaissance observations. This is now possible because in July 1995, 270 pages of SRI reports were declassified and released by the CIA, the first, but not the only, sponsor of such programs as Grill Flame, Center Lane, Sunstreak and Star Gate.

Although various unclassified aspects of the early work led by Puthoff and Targ have drawn media attention for some time, the bulk of the funded research was carried out between 1986 and 1995, directed by May. Building on the Puthoff-Targ findings, rigorous new tests were developed by May's team to try to identify the relevant variables and explore their dependence on space and time. Contrary to the implications of some media accounts, these efforts concentrated on developing proper scientific controls and were in fact guided by a Scientific Oversight Committee which included a Nobel Laureate, a former Major General, and internationally known professors of statistics, psychology, neuroscience and astronomy. It is estimated that more than 80,000 pages of program documents remain highly classified.

Much of the opposition of mainstream scientists to ESP phenomena of this sort traces to the perplexing lack of appropriate space and time behavior. Electro-magnetic and gravitational forces diminish predictably with distance and, except in science fiction movies, never mysteriously propagate backwards in time. Taken at face value the ESP data suggest that information can be psychically accessed as easily across two continents as two doors down the hall. And apparent examples of bizarre time-shifting of perceptions abound.

One of the most curious results, reported by Targ, concerns a remote viewing by former Burbank police commissioner, Pat Price, in 1975. In one of the experiments Price described a target site, a swimming pool complex at Rinconada Park in Palo Alto,

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with "great accuracy." But he then went on to describe some non-existent water storage tanks at the psychically-viewed location. Targ discusses how 20 years later, in 1995 long after Price had died, he came across an Annual Report of the City of Palo Alto from 1913 that touted the "new municipal waterworks" built that year on the Rinconada park site. A photograph from 1913 shows two water tanks "just where Price had drawn them" 60 years later... long after they were gone! Skeptics would criticize this as "post hoc" interpretation, but numerous less dramatic examples of asynchronous perception suggest further study.

The retrospective reviews commissioned by the CIA in 1995 reached contrary conclusions. Jessica Utts, a professor of statistics at the University of California, Davis and a fellow of the American Association for the Advancement of Science states: "Using the standards applied to any other area of science, it is concluded that psychic functioning has been well established." This is disputed in the dissenting report by psychologist Ray Hyman, a professor at the University of Oregon. However, Hyman does agree with Utts on what the next steps should be, which in the Utts report is a recommendation for further funded investigation.

Whether this recommendation stands any chance of being implemented in today's budget climate is problematic. May's overall assessment of his program's results is that photographic-reconnaissance quality data were psychically obtained in approximately 15 percent of the operational remote viewings. While this would be more than sufficient to interest scientists, such a success rate appears to be too unpredictable to make the grade for continued intelligence funding.

Most of the operational data remain classified, and in his commentary on the reports May argues strongly that virtually all high quality data and testimony of key individuals were deliberately excluded from the unclassified review process. He makes the case that owing to political considerations the ground rules of the review were determined so as to produce an outcome that could be used to justify terminating the program. This would explain why the CIA chose to, in effect, disregard the conclusions drawn by Utts in its official briefing to Congress.

Further declassified examples of operational test-bed experiments may be accessed via the World Wide Web at <http://www.jsasoc.com/~csl/index.html>. *The Journal of Scientific Exploration* is the quarterly research journal of the Society for Scientific Exploration, an organization of scientists, engineers, medical practitioners and academic scholars formed to support the unbiased investigation of all types of anomalous phenomena. For further information contact the editorial office at: JSE, P.O. Box 5848, Stanford, California 94309-5848.

Engines Powered by Air??

REPORT ON BETTER WORLD TECHNOLOGIES DEMONSTRATION UNION STATION, WASHINGTON, DC March 5, 1996

by Bruce Maccabee, Physicist

At 7:00 PM I arrived at Union Station, an impressive marble building which is the hub of train and subway traffic in Washington, DC. I was there at the suggestion of Jim Dunn of NASA's Center for Technology Commercialization (West-boro, Massachusetts), who had told me that the Better World Technology company (BWT) was going to demonstrate devices that would be designed to allegedly create "free energy" out of the air. Needless to say, I was skeptical of this, but I thought that the demonstration might be interesting, anyway.

I was greeted at the door by what can only be described as religious fervor (I was blessed for being there), especially when they found out that I work for the Navy (this was *not* official Navy business, however). Dennis Lee, presenter, said that 900 hundred people had been invited (all congressmen, senators, the President, Vice President, generals at the Pentagon, etc.). The impressive marble meeting hall (complete with Corinthian columns) was large and held chairs for upwards of 500 - 600 people. However, only about two dozen people actually showed up.

Since there were plenty of seats to choose from I chose one that was two rows from the front. I was virtually alone, that close to the low stage at the front of the room. There was a professional video camera set up behind me to record the complete proceedings.

On the stage were several marvelous machines, obviously hand crafted... a mechanics dream. Two of the demonstration devices were related to Lee's low temperature heat pump design, one device was a low operating temperature reciprocating (free piston) engine, one was a non-working model of the Fischer piston engine (for illustration purposes only) and one was a modified Chrysler V-8 engine. Lee had two of his engineers with him.

Lee began his lecture at 7:30, which ultimately lasted 2.5 hours. He made general comments about how he wanted to build a device that would replace conventional power plants and thereby decrease pollution. The source of his power was to be, ultimately, the Sun. His big problems have been a lack of official support and, in his opinion, harassment and "evil activities" of the major power industry companies who want to prevent these companies from getting to market. Therefore he took his demonstration on a tour of 20 cities across the USA in order to generate public support, both spiritual and economic. He said he had traveled about 17,000 miles to make these presentations..

Lee's technical lecture was a "tough row to hoe" since he wanted to convey some rather abstract ideas to a non-technical audience and therefore had to describe and demonstrate some basic thermodynamics and physics before he could describe how his system was unique. Overall, I would say he did an acceptable job of presenting the basic technical ideas that his audience needed to evaluate his ideas. (This is not to say that I agree with all of his physical ideas or conclusions.) It was obvious that he knew a lot about it that he just didn t have time to say and numerous times he referred to technological developments he didn t have time to describe.

He began by claiming that he had developed technological fixes to a number of problems and that these were amazing breakthroughs which were being ignored. He compared his situation with that of the Wright brothers: it required 5 years from the first flight at Kitty Hawk to the time when it was finally generally admitted that, yes, heavier than air craft can be made to fly. According to Lee a major factor in this general admission that the Wrights had solved the basic problems of flight was a public demonstration supported by President Theodore Roosevelt. In continuing his analogy he suggested that it might take a similar demonstration to convince the world, or at least the USA, of his own technology breakthroughs. He made a modest proposal such as lighting the Statue of Liberty or the Lincoln Memorial with power taken from the

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air. At the end of the lecture he reiterated this proposal and suggested that Congressional support for such a demonstration would be a great help.

He then discussed the early history of his activities in the field of solar energy. Almost 20 years ago he decided to respond to President Carter's energy conservation initiative by making a 24- hour solar heat system. This led him into the development of a heat pump in order to provide heat from the air when the sun wasn't shining. Because he came from the "solar panel side" of the problem, he designed the collector of his heat pump like a large solar panel which could heat fluid under direct sunlight, as would any solar panel, but which also could be used as the evaporator of a heat pump at night. He chose low boiling point fluids so that evaporation would occur in the solar collecter at temperatures well below the water freezing point. His system has a heat exchanger and compressor and pump, like any other. The big difference is in the evaporator: instead of a coil of pipe which usually requires a fan to assure air circulation, his heat pump uses the solar panel and thus gives him much more area for absorbing heat from the air just by convection (no fan). Even if it got coated with ice it would not have to be defrosted. He claimed to reach output temperatures of 200-250 °F with his heat pump and that the Coefficient of Performance (COP) could be as high as 12, with 6 being a typical value. He presented a data sheet showing the performance of one of his systems in Minnesota in January 1983 where for 30 days it averaged a COP of about 5. He says that over a period of a couple of years his company built and sold a thousand or so systems.

He then turned to the next topic: an engine. Over the next many years, when he wasn't in trouble with his own company or in jail for some civil law problem for which he said he was not convicted, he tackled the problem of making mechanical energy from solar power. He wanted to power an engine with the heat from his heat pump. However, whereas most engines operate at very high temperatures (1,000 F), with his heat pump he could only get up to 200-250F. Therefore he needed an eingine that could use a working fluid that would boil at a much lower temperature. He assumed he would build an analog of the Rankine cycle steam engine at lower temperature. An MIT professor taught him about the discovery by Sadi Carnot (the father of physics, according to Lee) that temperature is the chief determinant of the efficiency of an engine: the temperature drop (difference) divided by the upper temperature of an engine operating between high and low temperature thermal reservoirs is the theoretical limit to efficiency. He found that if he had an engine that took in 3 units of heat (for example) converted to steam , lost 1/2 unit in the motor to friction and lost 1.5 units to the condenser (thrown away at low temperature) he would have 1 unit of work remaining... 33% efficient. In this case he believed he could take a heat pump with a COP of 3 and proceed thusly: the pump requires 1 unit of work to pump ("suck up") 2 units of heat from the air (by means of the evaporator) and thus provide 3 units (2 +1) units of heat (power) at the high temperature; the high temperature fluid is made to run into an engine of E = 1/3 efficiency in converting heat to 1 unit of mechanical work and 2 units are discarded as waste; the 1 unit of mechanical work can be used to drive the heat pump. The result would be a self-sustaining, break-even system. If he could get a greater COP, then there would be "work to spare"..... mechanical energy (power) from the air! Mathematically speaking, the work available for external application is proportional to the difference (COP-1/E).

After explaining this idea (less the mathematical relation) he demonstrated an air motor run by a burst of refrigerant gas. This proved, he said, that refrigerant gas has the capability to drive a motor (refrigerant is not "wimpy"). The motor was coupled to a generator which, in turn, was connected to light bulbs which lit while the gas burst was passing through the motor. However, this was not a closed system and it ran for only a few seconds.

Next he demonstrated a free piston motor with its working fluid (refrigerant) operating between the hot water in a non-pressurized water tank - 150 °F (?) - and the cold water typical of a well - 50 °F (?). This was a continuously operating system in which the cold water was used to condense the vapor from the refrigerant after it passed through the motor (free piston). The system had a heat exchanger to heat the fluid before it entered the piston and another heat exchanger to cool the fluid after it left the piston. Beside providing all the power needed to run the various parts of the engine it also ran a generator which lit a bunch of light bulbs. This proved that he could get a continuously operating closed cycle engine operating at low temperatures such as might be achieved by using a solar collector, or his heat pump to provide the high temperature and a well or a lake to provide the low temperature.

He then returned briefly to the discussion of the Carnot cycle efficiency and demonstrated that at the high and low temperatures he wanted to operate, 250 °F and 55 °F, the best Carnot efficiency he could get would be 27%. (First convert to absolute temperature in degrees R by adding 460 to each temperature; then form the ratio (710 °F - 515 °F)/(710 °F) = 195/710 = 0.27) . The break even point then would be achieved by coupling a Carnot engine with E = 0.27 to a heat pump with COP = 1/.27 = 3.7 or about 4. Thus he would have to achieve a COP of more than 4 to make a complete practical system. Furthermore, anyone using such a system would have to have available an infinite thermal reservoir of 55 °F or lower. This would be like having a lake or a well in the back yard. Not everyone would-have that, of course. The problem, as he saw it, was that the motor was not sufficiently efficient. Enter Mr. Fischer with a "non-Carnot" engine.

According to Lee he was in Colorado (?) demonstrating his heat pump inside a walk-in refrigerator where the temperature was minus 10 °F. His engine was making very hot water. Mr. Fischer saw this demonstration and afterward said to Lee, "You've got the world's most efficient heat pump. I've got the world s most efficient engine." They decided to get together. Apparently the thing that really impressed Lee about Fischer's engine is that there is no (apparent) condenser, and hence the low temperature heat is not lost. It seemed to Lee that Fischer's engine, combined with the heat pump, could fulfill Lee's dream of providing infinite cheap "solar" energy for everyone. (Here it must be noted that without the Sun the earth s atmosphere would be quite cold and hence, any atmospheric temperature above more than -100 °F or so must be attributed to the diurnal heating by t he sun, i.e., solar energy stored in the atmosphere.)

Fischer's engine is piston driven by a "chunk" of fluid near its critical temperature. Lee demonstrated what would happen on a transparent model piston. The chunk of fluid is at a high pressure and temperature. (On a PV diagram of the working fluid, find the critical point; now move "down and to the left" along the liquid side of the coexistence curve a short distance. This is the starting point of the thrust

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portion of the cycle.) This chunk is instantaneously forced into the small space between the end of the piston and the top of the cylinder, and then the inlet valve is closed. The high pressure pushes the piston. Thus, unlike the typical is Rankine cycle, the fluid at the top of the piston is not coupled to a large pressure reservoir and, unlike the Rankine cycle, the ensuing expansion of the fluid and corresponding motion of the piston is not at constant pressure. Lee argued that the fluid, instantaneously released from the high pressure environment it was in before it was injected, would now push the piston far enough to allow it to flash into steam and expand, thus moving the piston even more. (It would go through a phase change and travel into the gas phase on the right hand side of the coexistence curve in the PV diagram. Possibly it would follow an isotherm for a short distance.) As the piston moves the volume available to the fluid would increase and it would thus lower in both pressure and temperature. By the time the piston was at the end of its motion the temperature would be low enough so that most of the fluid would be in the liquid phase, and it would simply run out of the piston by gravity (or be forced out by the low pressure of the remaining gas) and the liquid could be pumped directly into the high pressure chamber for reheating. There would be no need for the condenser which is typically between the piston output and the pressure tank input. It is obvious that this method keeps the maximum useful heat within the piston. (What he did not point out is that the piston itself must be cooled, or else it will eventually get hot enough to revaporize any fluid that tended to condense.)

Lee said he made a Fischer engine with 4 moving parts, lightweight, 6 inches diameter that put out 80 H.P. He did not demonstrate this engine; he merely showed a photograph of it. Apparently he has not created a low temperature Fischer engine that could operate with his heat pump.

Lee projected it would cost in production about $2,500 to make a combined Fischer-Lee (or Lee-Fischer) power source that would be completely independent of any external sources of power.

The final demonstration was of a Fischer-Brower-modified Chrysler V-8 engine in which they had simply replaced the valve cover and valves on one side with a special device to allow operation from compressed carbon dioxide. Mr. Brower was present to help demonstrate the engine that he modified. They demonstrated that the engine could give great static torque (not surprising) and that using the appropriate valve device and two tanks of gas they could make the engine run on CO_2. It was an open cycle demonstration (the CO_2 was exhausted as a gas). The implication was that they could make it run on a working fluid, in a closed system using the heat pump to provide the high temperature and hence high pressure fluid that would be injected into the cylinders. Lee claimed that he could convert any such engine rather easily ($1,500 complete conversion for a typical car).

Of course, the blockbuster claim was that once modified according to his Lee-Fischer-Brower (LFB) method, any car could "run on air," that is, the heat pump would take heat out of the air, raise this heat to a high temperature, use this heat to heat a working fluid for the engine and thus drive the car engine. A small portion of the mechanical power of the engine would, of course, be used to drive the heat pump. I presume that one would need an initial external (to the engine and air) source of heat, like a battery and starter motor, to start the whole process which then, according to Lee, would be self-sustaining. I presume that the thought of "driving on air" left some of the audience breathless. Especially breathless were the supporters and dealers of Lee's technology who could just imagine converting all the cars on the road to the LFB engine.

Lee spent that last 1/2 hour of his lecture explaining how he could see that the bold application of his technologies could cause economic fluctuations in the the power, coal and petrol industries. For example, if he could supply each house with his system then each house would become a source rather than a sink of electric power. The only physical requirement for the house would be that there be enough area for a large solar collector/evaporator. He pointed out that the impact on the economy could be minimized. The oil industry would still have plenty of work making plastics and petrochemicals. The power grid companies would still have business distributing the excess power from individual homes to locations were there was not enough room for large solar collectors (e.g., apartment houses, office buildings, etc.). There would also be large energy farms using large solar collectors in place of the oil fired, coal fired and fission fired power generator plants we now have. Only the power generation companies would go out of business. But even those who worked in power plants would find jobs making LFB power systems for houses. And, of course, there would be much less pollution leading to better health and so on. Car engines would last longer since they would operate at lower temperatures and with better efficiency and last for a million miles or more.

All in all the lecture was given with enthusiasm and was quite impressive.

But is he correct? That is the question.

Let's break this into parts. The heat pump seems to be proven technology. Whether it is really as good as he says, it nevertheless seems to be better than the systems sold by the "Big Boys" of heating and cooling. (So, why isn't he building these and selling them by the truckload?) The Fischer engine is less well proven. He did not provide any actual data on its efficiency and operating parameters.

The third leg of his breakthrough triumvirate is coupling the heat pump with the engine to suck thermal power out of the air and convert it to mechanical power. This raises the question of whether or not it is possible that a self-contained device could take heat energy (power) from the air (or any heat source at low temperature) and raise its temperature and use that higher temperature heat energy (power) to operate a self-sustaining mechanical system that produces useful mechanical work.

Consider the Kelvin-Planck statement of the Second Law of Thermodynamics: "No process exists whereby the only effect is to convert heat from a single thermal reservoir completely to work." (Thermophysics, by Allen King, Freeman and Co.1962). Imagine the heat pump- engine combination to be completely surrounded by a box that insulates it from the surrounding air, except for the evaporator which is outside this box. Imagine that a crankshaft protrudes from the box. When the crankshaft turns, mechanical work (power) can be taken from the crankshaft. So now, if Lee were correct, you would have a system in contact with ONE heat reservoir (air) which is producing mechnical work, in contradiction to the K-P statement of the second law. Suppose this system actually started to operate but with no work (power) taken from the shaft. That is, assume the heat pump motor is turned on by external means to create enough heat to start the engine. Once the engine is operating all of its mechanical output is used to drive the

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heat pump motor and the external power source (electricity, for example) is disconnected. The best you could hope for is that this system would operate for a while, but not for a long time because the continual accumulation of thermal energy in the box would cause all of the devices in it to get hot. Eventually they would all be at the temperature of the output of the heat pump. Since the heat pump driven motor does require that it operate between temperature differences it would stop. In fact, long before the inside of the box reached the high temperature of the pump the efficiency of the motor would decrease as the condenser (or piston) heated up. Thus, the process would shut itself down as the engine must have a lower temperature to operate into, no matter what the design.

Now suppose the box is removed. Air can circulate around the engine to cool it. The system is now taking heat from the air at its ambient temperature (by having thermal energy flow from the air into the cool evaporator) and returning it to the air at its ambient (by allowing it to cool the hot piston or condenser of the engine and all the parts which get hot from friction). There has been no net heat flow out of the reservoir, hence no net work. The total system is coupled to only a single heat reservoir. Although power (energy) is conserved, there is no net power flow out of the reservoir so there is no power (energy) available to take from the motor.

The bottom line is that the heat pump may be great and the Fischer engine may be efficient, but it seems highly unlikely that the combination of these (or any devices) can simply take heat from the air and produce useful work. However, I'm sure that if such a system is built and it works, the USA would be happy to let Mr. Lee use it to light the Lincoln Memorial, or any other edifice, to prove he is right.

Pulsed Power Circuit For Calorimetric Tests

by Bruce Vicknair

I've always been intrigued with Boyer's[1] thermal exploration of acceleration and Cole-Puthoff's colliding systems [2], Here is a simple inexpensive circuit that allows the student or casual experimenter to test various solid/liquid **p** junctions, microplasmas, Casimir gaps, and Pons-Fleisch-mann cells for anomalous heat. The heart of this switch is a unijunction transistor operating in the relaxation oscillator mode driving a pulse transformer. Dual outputs drive the gates of SCRs used in a high impedance scheme[3]. Series resistors prevent the SCRs from latching as the frequency is varied from 70 to 2000 shots per second. The discharge pulse sources from a low inductance capacitor. This isolated output section allows high peak energy to be discharged into the experimenter's target at low duty cycles (<.2%). Almost any medium current (6-16A) high voltage SCR will work. I have even used "blue pack specials" at $1.19 to deliver 22.5kw pulses into a dummy load. Do not use sensitive gate types or those with a low (<20ma) holding current.

After construction it is possible to test the circuit without an oscilloscope. Install a one ohm resistor on the output and connect a DC meter across either HV charging capacitor. Power up the circuit with SW1 off. You should see the full HV potential. Closing SW1 should result in a drop if the trigger circuit is running. At low firing rates the HV will be at its highest. If the voltage remains low continuously, R6-7 value should be increased. All leads should be as short as possible and loads should preferably be noninductive.

I purposely did not use exotic FETs or IGBTs in this example so that the the overseas experimenters might have a chance of finding all components.

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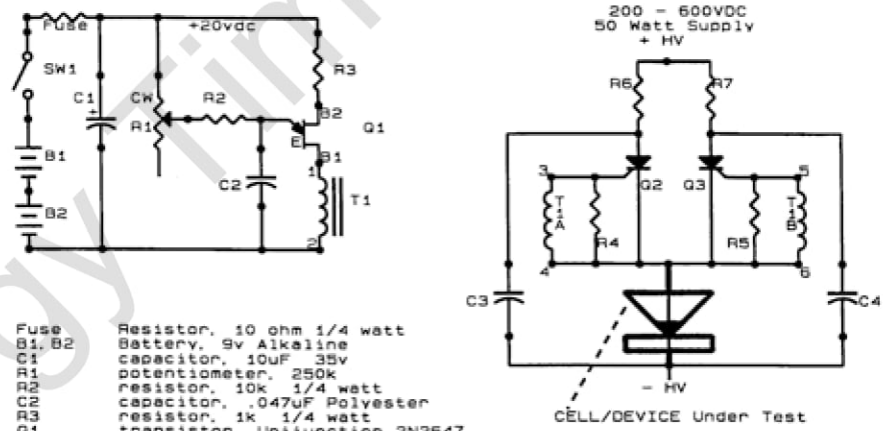

Fuse	Resistor, 10 ohm 1/4 watt
B1, B2	Battery, 9v Alkaline
C1	capacitor, 10uF 35v
R1	potentiometer, 250k
R2	resistor, 10k 1/4 watt
C2	capacitor, .047uF Polyester
R3	resistor, 1k 1/4 watt
Q1	transistor, Unijunction 2N2647
T1	Pulse transformer- Dale PT-20-106 or equal
C3, C4	capacitor, .1uF Metallized Polyester 630V
R4, R5	resistor, 470 ohm 1/4 watt
R6, R7	resistor, value = HV/.02 (usually 10k-30k) 10 watt
Q2, Q3	SCR, 400-800v 6-16A type 2N4174 or C122N1 or equal

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TWO ZONES OF "IMPURITIES" OBSERVED AFTER PROLONGED ELECTROLYSIS OF DEUTERIUM ON PALLADIUM

J. O'M. Bockris and Z. Minevski, Department of Chemistry, Texas A&M University, College Station, TX 77843-3255

In experiments carried out recently in which hydrogen was electrolyzed from water in contact with a palladium electrode, the concentration and depth of impurities were measured as a function of electrolysis time. It was found that after 3 weeks, two different sets of impurities could be observed, one set within 50Å of the surface and another set different chemical spaces, about 1μ inside the metal.

Thus, the XPS measurements (Table 1) showed materials which correspond roughly to elements found in the solution after three weeks by ICP measurements (see Fig. 1). The concentration of platinum found in the palladium, for example, rose to a maximum at about 8-11 Å from the surface and decreased exponentially so that by 50Å from the surface no further platinum could be seen. Similar concentration profiles were observed for silicon and zinc.

From these XPS determinations it can be concluded that the impurities measured, which spread no further than a few tens of Å inside the Pd, originated in the solution by means of electrochemical deposition or adsorption on the electrode surface and subsequent diffusion into the electrode.

In confirmation of this, the information in Fig. (1) shows materials in solution as a function of the time of electrolysis.

Energy dispersive spectroscopy was also used to seek material which might be further into the metal. In EDS, the maximum intensity of the signal arises from a greater depth than that of XPS (Λ). In fact, for palladium, for a 20 kV X-ray beam, the escape depth maximizes at about 2μ inside the palladium and the signals found both after one hour's electrolysis, and then after three week's electrolysis, are shown in Figures 2 and 3, respectively. It is seen that new nuclei have appeared at this depth in the presence of hydrogen at high fugacity (overpotential more than 0.5 volts) .

The concentration of the new atoms is in the range 1-10 atomic percent. The materials shown in Table 2 have no relationship to the impurities in the solution (further, diffusion of the materials cited in Figures 2 and 3, into depth of ~ 1μ could not occur in three weeks).

Thus, protons at high fugacity in Palladium may give rise to new nuclei ("proton capture"). These results are similar to those of Karabut, Kucherov and Sammatinova (2) who found many new materials formed in palladium after electrolysis. Similar results, according to T. Passed (3), were found by K. Wolf after examination of his palladium electrodes subject to similar electrolysis (radioactivity was also observed in this study). T. Ohmori and Enyo (4) have reported the formation of new iron nuclei in gold and palladium cathodes; J. Dash (5) has described the formation of Au and Ag on Pd electrodes after hydrogen evolutions. Correspond-

DEPTH	ELEMENTS ON THE ELECTRODE SURFACE (ATOMIC %)			
(A)	Pd	Pt	Si	Zn
5.0	0.39	49.16	20.02	30.42
7.5		78.93	13.98	7.08
10.0	0.34	78.38	11.35	9.94
12.5	6.90	65.53	12.38	15.19
15.0	40.99	40.19	6.40	12.41
25.0	84.36	5.63	1.87	8.13
35.0	93.16	2.12	2.36	2.36
45.0	96.87	1.54	0.51	1.07
55.0	96.81	1.06	1.06	1.06

TABLE 1. Atomic weight percent of elements found on the electrode surface after three weeks of electrolysis (XPS).

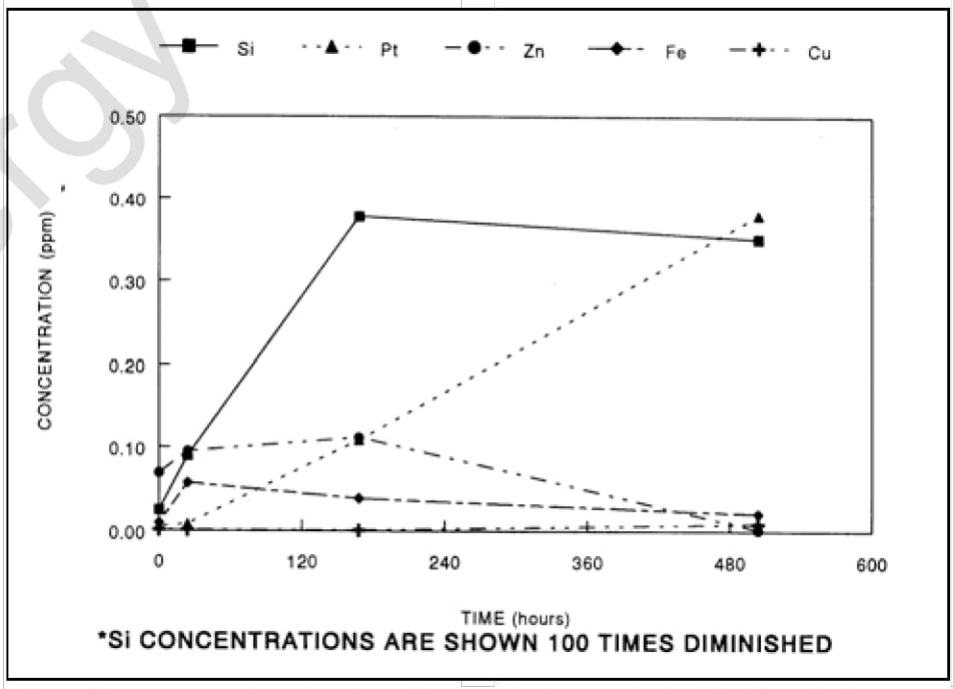

FIGURE 1. Concentration time dependence of Pt, Zn, Fe, Cu, and Si from ICP measurements during a 3 weeks period.

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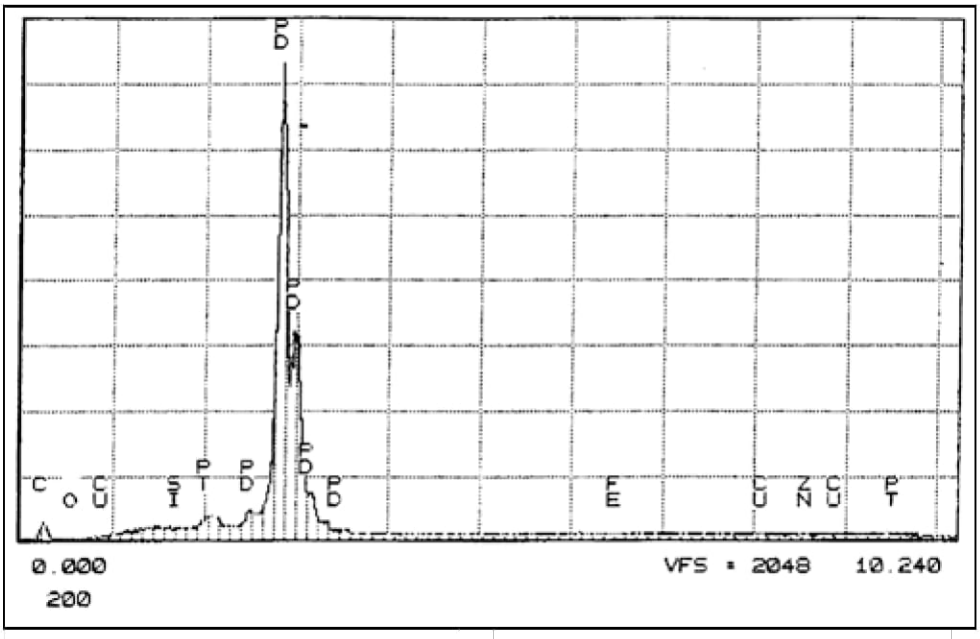

FIGURE 2. EDS scan of Pd electrode after one hour of electrolysis.

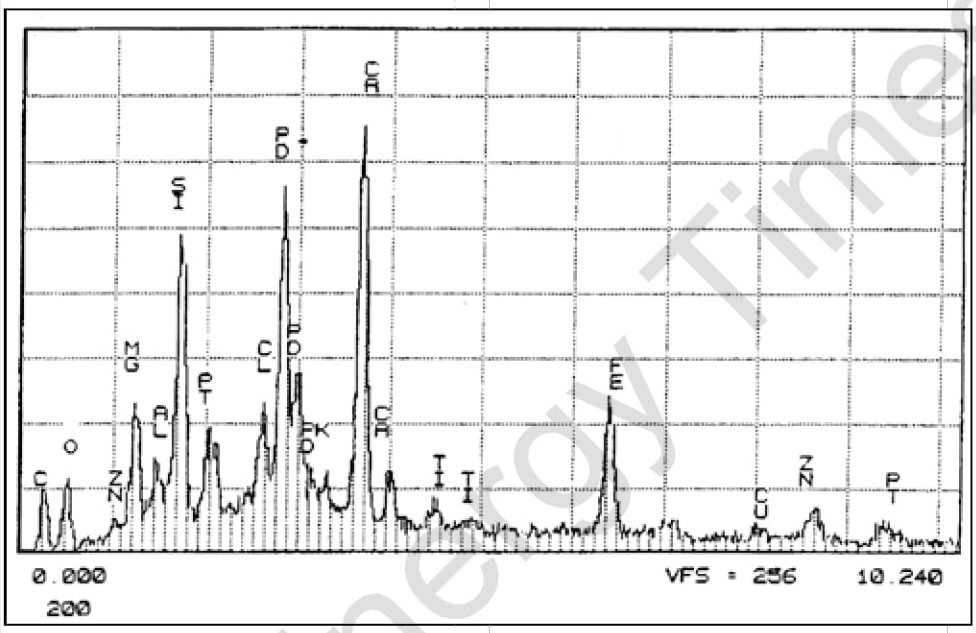

FIGURE 3. EDS scan of Pd electrode after three weeks of electrolysis.

ingly, Bush and Eagleton (6) have observed new stronthium during the electrolysis of platinum in a rubidiumcontaining solution; whilst Notoya (7) has found that new Ca^{++} forms K^{+} in solution. Such results are, to some degree, rationalized by models of the excited nucleus discussed by Greiner et al (8).

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TABLE 2. - *ON NEXT PAGE*

ELECTROCHEMICAL INSERTION OF HYDROGEN INTO METALS AND ALLOYS

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Abstract

Hydrogen in metals has possible applications in various energy storage devices. For the palladium-deuterium system, excess power production and other anomalous effects have been reported. This study focused on hydrogen and deuterium insertion into palladium and deutenum insertion into various palladium-boron alloys. The condition of the metal surface is a mayor factor in the insertion of hydrogen or deuterium into palladium or palladiurn-boron alloys. Cracks or other surface defects prevent high loading levels of hydrogen in metals. The addition of boron to palladium does not affect the initial loading rate, but slows further loading to higher levels. The presence of boron in the palladium significantly slows the rate of the deloading process.

Introduction

Hydrogen in metals has possible applications in rechargeable battery systems, off-peak energy storage for electric utilities, and as the storage of hydrogen as a portable fuel for automobiles and buses. In addition, hydrogen embrittlement and hydrogen-related stress corrosion cracking are very important practical problems for metals and alloys.

Anomalous effects have been reported for the palladium-deuterium system, including excess power production. This anomalous power effect apparently

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ELEMENT	ELEMENTS AT 1 μm DEPTH (ATOMIC %)		
	VIRGIN Pd		ELECTROLYZED Pd 3 weeks/EDS
	JOHNSON MATTHEY/ICP	PRESENT WORK/EDS	
Mg	$< 1.0 \cdot 10^{-4}$	-*	6.7 ± 1.0
Ag	$< 1.0 \cdot 10^{-4}$	-*	1.9 ± 1.0
Si	$8.0 \cdot 10^{-4}$	-*	10.2 ± 1.0
Cl	-	-*	3.0 ± 1.0
K	$9.0 \cdot 10^{-4}$	-*	1.1 ± 1.0
Ca	$3.5 \cdot 10^{-3}$	-*	19.9 ± 1.0
Ti	$< 3.0 \cdot 10^{-4}$	-*	1.6 ± 1.0
Fe	$< 4.0 \cdot 10^{-4}$	-*	10.5 ± 1.0
Cu	$4.5 \cdot 10^{-3}$	-*	1.9 ± 1.0
Zn	$< 4.0 \cdot 10^{-4}$	-*	4.2 ± 1.0
Pt	$1.0 \cdot 10^{-2}$	-*	7.1 ± 1.0
Pd	99.80	98.10 ± 1.0	31.9 ± 1.0

* Lover than measuring limit of EDS.

TABLE 2. Concentrations of impurities (Atomic weight percent) found in virgin Pd after three weeks of electrolysis (EDS) **[For ARTICLE (Bockris & Minevski) on Previous Page.]**

requires a loading ratio of D/Pd exceeding 0.85 (Reference 1).

This research will investigate the amount of hydrogen and deutenum that can be electrochemically inserted into palladium and palladium-boron alloys. Factors that affect the extent of loading and the rate of the loading and deloading processes will be investigated.

Approach

The hydrogen or deutenum loading of palladium or palladium alloys will be investigated by the weight gain of the electrode during constant current electrolysis in H_2O-LiOH or D_2O-LiOD solutions. The weight gain of the metal (M) due to hydrogen loading can be represented by

$$M + xH_20 + xe^- \; MH_x + xOH^- \qquad (1)$$

The rate of deloading will also be investigated by the loss of weight represented by

$$MH_x \rightarrow M + (X/2)\, H_2 \qquad (2)$$

or by coulometry where the absorbed hydrogen is reacted electrochemically as represented by

$$MH_x \rightarrow M + xH^+ + xe^- \qquad (3)$$

In addition, the use of sensitive calorimeters can determine the rate of the loading process by measuring the power produced during the initial exotherrnic loading process. For exarnple, $\Delta H = -35{,}100$ J per mole of D_2 for the formation of PdD_X for $x < 0.6$ (Reference 2).

Results/Discussion

Initial studies were conducted on palladium rods (1-rnm diameter) and palladium sheet electrodes in H_2O + 0.1 M LiOH solutions to test the reliability of the weighing method. Upon interrupting the constant current electrolysis, it was found that the loss of weight (Equation 2) could be readily measured and that the weight change was linear with time. For five or more weighings over a 10-minute period, the plot of the H/Pd ratios versus time was extrapolated back to zero minutes to yield the initial H/Pd loading when the electrolysis was interrupted.

Loading levels of H/Pd ≥ 0.7 were readily obtained in all experiments. Both a 1-mm diameter palladium rod (Johnson-Matthey) cathode and a palladium sheet cathode (Tanaka Metals, Japan) were used in these investigations. The highest loading level for the palladium rod was H/Pd = 0.923 while the highest value for the palladium sheet was H/Pd = 0.821. No obvious correlation between the loading level and the current density could be established. The type of anode used in the cell apparently affected the loading level. Higher loading levels were obtained using a platinum anode than when a nickel anode was employed. The H_2O-LiOH solution eventually became dark due to corrosion products when the nickel anode was used.

Although a loading level of H/Pd = 0.7 was readily obtained in all experiments using palladium cathodes, only a few experiments yielded H/Pd ratios approaching 0.9. The highest loading occurred following the heating of the loaded palladium rod with a heat gun that caused it to glow red due to a run-away exothermic reaction of the hydrogen exiting the surface with oxygen from the air.

The study of the H/Pd ratio over a 21 day period for a palladium rod cathode showed several peaks and valleys in the loading ratio versus time. The H/Pd ratio varied from 0.79 after 3 days to a low of 0.72 at 6 days and a maximum of 0.92 at 16 days. There was no obvious correlation between the loading ratio and any experimental vanable. For most experiments, the change in H/Pd after interrupting the electrolysis was generally about -0.01 per rninute.

A new calorimeter designed and built at China Lake (Reference 3) was used to measure the heat of absorption of deuterium into the palladium rod cathode. This result is shown in Figure 1. A power output of approximately 6.5 mW is observed for 2 hours. This yields 47 Joules, which compares very favorably to the expected 44 Joules based on the cathode size (1 mm x 43 cm), a loading level of $PdD_{0.6}$, and using the reported value of $\Delta H = -35{,}100$ J

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TABLE 1. Loading Studies by the Weighing Method.

Time (days)	Pd-0.75% B (Cell C)	Pd-0.75% B (Cell D)
7	0.580	0.550
12	0.614	0.594
100	0.85	0.63

per mole of D_2 (Reference 2). Figure 1 shows that most of the loading up to D/Pd = 0.6 is completed within 2 hours of the start of the electrolysis. Further loading beyond the D/Pd = 0.6 ratio yields a discontinuity in the enthalpy value, and the loading process becomes endothermic (Reference 2).

Loading studies for two palladium-boron alloys, both containing 0.75 weight % boron, are shown in Table 1. The loading process is much slower with the boron present than observed with pure palladium. While loading levels of D/Pd = 0.6 could be attained within a few hours for palladium cathodes, nearly 12 days of electrolysis are required to reach this loading level for the palladium-boron alloy (Table 1). Judging from Table 1, the Pd-B alloy in cell C slowly loaded to higher levels. After 100 days, the D/Pd ratio was 0.85 for the alloy in cell C but only 0.63 for the alloy in cell D. A surface flaw caused this difference. The Pd-B alloy used in cell D had a long folded-over metal region produced by the swaging of this very hard material. This acted as a long crack in the surface. Cracks or similar surface defects are a major factor in preventing high hydrogen or deuterium loading levels.

Further experiments investigated the effect of the boron concentration on the D/Pd loading level. Table 2 presents loading studies by the weighing method for Pd-0.50 weight % B and Pd-0.25 weight % B cathodes. Loading to the D/Pd = 0.6 level becomes considerably faster as the amount of boron is decreased as shown in Tables 1 and 2. Higher D/Pd ratios are obtained initially for the alloys containing the smaller amount of boron.

TABLE 2. Loading Studies by the Weighing Method Following 5 Days and 10 Days of Electrolysis.

Electrode	Xo (5 days)[a]	Xo (10 days)[b]
Cell A Pd-0.5% B (#94081701)	0.643	0.640
Cell B Pd-0.5% B (#94081702)	0.604	0.652
Cell C (Pd-0.25% B (#94081801)	0.692	0.716
Cell D Pd-0.25% B (#94081802)	0.647	0.695

[a] I = 50 mA for 5 days.
[b] I = 100 mA for the second 5-day period.
NOTE: Microscopic examinations showed surface nicks and scratches but no major flaws on electrodes.

Calorimetric studies at China Lake showed that the initial exothermic loading of deuterium into the Pd-B alloys is nearly as fast as observed with pure palladium cathodes. This was a surprising result. Further loading to higher levels, however, appears to become very slow for the Pd-B alloys compared to the palladium cathodes (Tables 1 and 2).

Coulometric measurements of the loading were attempted for the palladium-0.75 weight % B alloy. The currents obtained by potentiostatically controlling the cell voltage were only 24 mA, hence less than 10% of the deuterium could be reacted electrochemically (Equation 3) even after 28 hours of electrolysis. Measurements by the weighing me-thod also showed very slow deloading rates for the Pd-0.75 weight % B alloys, i.e., the D/Pd ratio change was less than -0.001/minute. This is more than ten times slower than observed for palladium electrodes. It took 2 weeks to reach an equilibrium weight for these alloys.

Deloading studies by the weighing method for the Pd-0.50 weight % B and Pd-0.25 weight % B alloys are shown in Table 3. The deloading rate again is much slower than for palladium cathodes. About 10 days are required to reach an equilibrium weight.

Tables 1-3 show that small amounts of boron added to the palladium can produce major changes in the deuterium deloading rates. The initial rates of loading, based on calorimetry, are similar for palladium and palladium-boron alloys. Perhaps boron accumulates in the grain boundaries during the initial loading and then hinders both the further ingress and egress of hydrogen or deuterium into and out of the metal lattice.

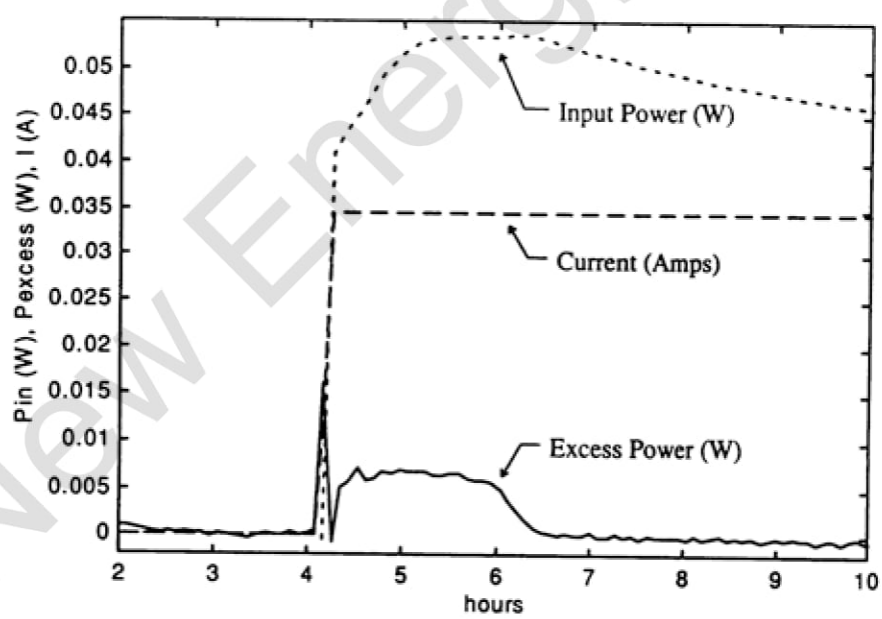

FIGURE 1. Measurement of the Exothermic Heat of Absorbtion of Deuterium Into a Palladium Rod Cathode Using the New Calorimeter Developed at China Lake.

Conclusions

Loading and deloading of hydrogen and deuterium in palladium and palladium-boron alloys can be readily studied by the weighing method. Cracks or other surface flaws affect the degree of loading that can be obtained. Small amounts of boron alloyed with palladium can slow the deloading rate by a factor of ten or more.

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TABLE 3. De-loading Studies by the Weighing Method.

TIME (HOURS)	PD-0.5% B (CELL A)	PD-0.5% B (CELL B)	PD-0.25% B (CELL C)	PD-0.25% B (CELL D)
0	0.617	0.643	0.687	0.687
12	0.490	0.497	0.518	0.512
36	0.350	0.368	0.446	0.367
67	0.228	0.261	0.215	0.190
112	0.152	0.161	0.108	0.069
181	0.100	0.051	0.034	0.010
282	0.065	0.003	0.010	0.003

tems," Final Report (in progress).

Significant Scientific Accomplishments

This project demonstrates that the loading and deloading of hydrogen and deuterium in palladium and palladium-boron alloys can be readily measured by the weighing method. Factors that affect the rate and extent of loading were identified. Cracks and other surface flaws limit the loading levels that can be obtained. Small amounts of boron can exert large effects on the rate and extent of loading and deloading processes. Calorimetry can be used to measure the initial rates of hydrogen or deuterium loading into metals.

Technology Impact

The electrochemical loading and deloading of hydrogen in metals is an important factor in metal/hydrogen rechargeable battery systems. Factors that affect these loading processes are identified. Anomalous effects in deuterated metals also require the attainment of high loading levels.

Fleet Impact

This research could impact the development of energy storage systems as well as the development of anomalous power production in deuterated metals.

EDITOR's NOTE: Dr. Miles, in sending me this preprint, wrote: "This is a recent report relating to loading studies. I am no longer working in this field since the Navy has ceased funding on this topic." I think that every U.S. citizen, hearing about this excellent work that no longer receives funding should ask their representatives: **WHY IS THIS?** After all, the "Fleet Impact" statement by the authors , is very significant, is it not? —E. Mallove

THE GENESIS OF THE UNIVERSE AND ZERO POINT ENERGY

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(Original Draft, July 1, 1994)

ABSTRACT

The idea that something can be created from nothing has always been considered to be impossible. This manuscript presents a historical account on the subject of creation. Recently, it has been shown that the gravitational field contains negative energy. Contemporary ideas on the subject of creation demonstrate the existence of a link between the energy in matter, zero point energy, and the negative gravitational potential of the universe. These new ideas are explored. Finally, experiments, which seem to be creating energy, are examined.

INTRODUCTION

Since antiquity the genesis of the universe has been a subject of thought, study, and speculation by the greatest minds in philosophy and science. The original ideas on genesis were developed by philosophers. Some of the original philosophers were Greek. It became apparent to the Greeks that all things came from other things. The great Greek philosopher Plato (427-347 BC) described this with his idea of forms. According to Plato the form was the property that made a thing what it was. Aristotle (334-322 BC) developed the idea of forms and concluded that each form was composed of a substance. The form of a substance could be changed but the substance itself was eternal. The question then was where did the original substance come from? The conclusion that the ancient Greeks drew was that a prime mover created the original substance. This prime mover was God.

The Greek Empedocles defined what the fundamental substances of the original creation were. To him the fundamental substances were earth, air, fire, and water. Later the Greek Democritus redefined these original substances as atoms. According to Democritus these atoms were produced in the original creation and were eternal.

In the Middle Ages the greatest thinkers on the subject of creation were theologians. One of these theologians was St. Augustine (354-430 AD). It became apparent to St. Augustine, like it did to the Greeks, that all things came from other things. If the material substance of the universe had not been created then this substance must have always been. If the substance of the universe has always been, then time had no beginning. Every event is precipitated by a prior event. Without a first event everything that could have happened should have happened in the infinite past. For current time to have meaning there must have been a first event or moment of creation. St. Augustine used a Latin word to describe this creation process called exnihilo. This word means to create something out of nothing. St. Augustine concluded that an infinite source or prime mover created the universe exnihilo. This concept was developed to an apex by St. Thomas Aquinas (1225-1274). He came up with a line of reasoning in his arguments from design. These arguments were based on the idea that the substance of the universe required a divine origin.

PROPOSED THEORY

Today scientists are studying the problem of creation. Science does not address the question of who created the universe. Scientists have rules that they work by called conservation laws. Some of these conservation laws are the conservation of momentum, energy, and charge. Science addresses the question of how the universe formed within the framework of possibilities allowed by these laws. According to current theory and experimental evidence, these conservation laws always hold true. In more precise language, they are invariant with respect to time and location.

The scientific principle of the conservation of energy simply restates the old idea that something cannot come from nothing. According to the accepted theory of the Big Bang, the universe sprang from nothing 15 billion years ago. In 1973 the great contemporary physicist Edward P. Tryon demonstrated how the universe could have formed without violating the principle of the conservation of energy.(1) He said that the total energy of the universe is zero. He said that the positive energy of the things we observe is balanced by a negative gravitational energy. Therefore the creation was formed without violating the principle of the conservation of energy. Let's explore his idea. When something falls it

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CALENDAR

MIT Cold Fusion Day
January 21, 1995
Cambridge, MA

ICCF5 – Fifth International Conference on Cold Fusion
April 9-13, 1995
Monte Carlo, Monaco

Low-energy Transmutation Meeting (Private) At Texas A&M University
June 19, 1995

The Second International Conference on New Energy Systems and Conversions
July 31-August 4, 1995
Istanbul, Turkey

The 2nd World Hydrogen Summit
September 28
-October 1, 1995
Montreal, Quebec, Canada

16th Symposium on Fusion Engineering (SOFE '95), *with cold fusion component!*
October 1-5, 1995
Champaign, Illinois

Third Russian Conference on Cold Fusion and Nuclear Transmutation
October 1—8, 1995
Sochi, Russia

Power-Gen '95
(CETI cell demo)
Anaheim, California
December 5-7, 1995
(713-963-8833)

Alternative Fuels Conference and Exposition — Sponsored by SAE
December 6-8, 1995
San Diego, California

1996 International World Energy System Conference
June 19-21, 1996
Toronto, Canada

ICCF6—Sixth International Conference on Cold Fusion
October 13-18, 1996
Hokkaido, Japan

ICCF7—Seventh International Conference on Cold Fusion
1997, autumn-winter
Scheduled for the U.S.

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loses gravitational potential energy. The relationship between potential energy and position, in a force field, is given by equation #1.

$$\Delta PE = W_g = -\int F_g \cdot dr \qquad \text{Eqn. \#1}$$

According to Tryon's theory, if an object were to fall into the universe from an infinite distance away the gravitational potential energy the object lost would equal the total mass energy of the object. This is stated mathematically in equation #2:

$$mc^2 = -\int_{\text{infinity}}^{\text{radius of universe}} F_g \cdot dr \qquad \text{Eqn. \#2}$$

Assuming that the universe is spherical with an isotropic mass distribution, the amount of gravitational potential an object will lose upon falling to the edge of such a universe is given by equation #3. (2)

$$mc^2 = -GM_u m \int_{\text{infinity}}^{\text{radius of universe}} (1/r^2) \cdot dr \qquad \text{Eqn. \#3}$$

Given a radius "r" of the universe is 15 billion light years (1.42×10^{26} meters) and the known gravitational constant, G. the mass of the universe, M_u, may be determined: $M_u = 1.91 \times 10^{53}$ kg

If this is the mass of the universe then the total energy of the universe is zero. To check this result, the mass of the universe was calculated from its density and volume. The universe was considered to be a sphere. This sphere has a radius of 15 billion light years and is filled with matter of the same density as the density of space in our galactic neighborhood. This "local" density is equivalent to one proton of ordinary matter and nine protons of "dark" matter per cubic meter.(3)

Given that the volume of a sphere with a radius of 15 billion light years = 1.2×10^{79} M^3

Please note that at one proton mass per cubic meter this is also the number of protons in the universe.

The mass of the universe was derived from its volume and density in equation #4.

$$M_u = [(1 \text{ proton}/m^3) + (9 \text{ proton masses dark matter}/m^3)](\text{volume}) \qquad \text{Eqn \#4}$$

The mass of the universe according to this second argument is:

$M_u = 2.00 \times 10^{53}$ kg

Amazingly, the resultant masses agree even though they were determined by two entirely different methods. This agreement indicates that the universe has a total energy of zero and that it formed without violating the principle of the conservation ofenergy. Edward Tryon's idea has proven to be very profound.

THE GRAVITATIONAL INTERACTION

Energy is neither created nor destroyed. The total mass energy of the universe remains constant. This constant of energy is zero. The positive kinetic energy gained by accelerating matter is proportional to the product of the applied force "F" and the distance "d" through which the force acts. Refer to Equation #4.

$$+ \text{Energy} = Fd \qquad \text{Eqn. 4}$$

Given that the total energy of the universe is zero, an equivalent amount of negative gravitational potential must also be imparted to accelerated matter.

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CORRESPONDENCE OF THE NUCLEON CLUSTER MODEL WITH THE PERIODIC TABLE OF ELEMENTS

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The author has developed a new model of nuclear structure which is completely systematic, periodic, and symmetric. This model* (the Nucleon Cluster Model, or NCM) is based on three "building blocks" for beta-stable nuclei: a neutron-proton cluster (NP), a neutron-proton-neutron cluster (NPN) and a proton-neutron-proton cluster (PNP). The author has been frequently asked questions by colleagues about how this new nuclear model relates to the Periodic Table of Elements, which was discovered by the Russian Mendeleev in 1869, and is universally recognized by scientists throughout the world. This paper will deal with that relationship, and will demonstrate that there is a one-to-one relationship between the two models.

One of the first questions that must be asked is the following: Is there some commonality in the NCM that provides an explanation of the experimentally known stable isotopes of a given element? The answer lies in the relationship of NP clusters and NPN clusters. Let us, as an example, examine Figure 1, giving nucleon cluster structures for the three stable isotopes of the element Magnesium (Z = 12), using NP = 3, 6 and 9 (a, b, and c).

Clearly, several key conclusions can be drawn from the above data:

1. The number of NP clusters decreases, the number of NPN clusters increases, and the sum of NP and NPN clusters is constant for each isotope of increasing mass (A) in a given element.
2. The number of PNP clusters is constant for all isotopes of a given element.
3. The Z of an element is always given by (NP + NPN) + 2 x PNP.

One issue remains to be addressed: Does a systematic cluster relationship exist, for example, among cluster structures of the noble (rare) gases, as shown in the Periodic Table of Elements (He, Ne, Ar, Kr, Xe, and Rn)? For answers, let us examine Figure 2.

Figure 1 - Example: Nucleon Cluster Structures for Stable Isotopes of Magnesium

	a		b		c	
	(NP + NPN)	+ PNP	(NP + NPN)	+ PNP	(NP + NPN)	+ PNP
12-24	(3 + 3)	+ 3	(6 + 2)	+ 2	(9 + 1)	+ 1
12-25	(2 + 4)	+ 3	(5 + 3)	+ 2	(8 + 2)	+ 1
12-26	(1 + 5)	+ 3	(4 + 4)	+ 2	(7 + 3)	+ 1

Figure 2 - Nucleon Cluster Description of He, Ne and Ar

	Z	Element	Symbol	(NP + NPN)	+	PNP	=	Σ_c	
	2	Helium	He	2	+	0	=	2	
8				4		2		6	6
	10	Neon	Ne	6	+	2	=	8	
8				4		2		6	6
	18	Argon	Ar	10	+	4	=	14	

Figure 3 - Nucleon Cluster Description of Li, Na and K

	Z	Element	Symbol	(NP + NPN)	+	PNP	=	Σ_c	
	3	Lithium	Li	3	+	0	=	3	
8				4		2		6	6
	11	Sodium	Na	7	+	2	=	9	
8				4		2		6	6
	19	Potassium	K	11	+	4	=	15	

Let us also examine the cluster structures of some of the alkali elements, in Figure 3.

The regular systematics of the data in these two figures, in turn, lead to the following.

Following the systematics, clearly

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Figure 4 - Periodic Table - Atomic and Nuclear - Corresponding to Halides, Noble Gases, Alkalis and Alkaline Elements

		NP + NPN	+ PNP	= Σ_c			NP + NPN	+ PNP	= Σ_c			NP + NPN	+ PNP	= Σ_c			NP + NPN	+ PNP	= Σ_c
1	Hydrogen (H)	1	+ 0	= 1	2	Helium (He)	2	+ 0	= 2	3	Lithium (Li)	3	+ 0	= 3	4	Beryllium (Be)	4	+ 0	= 4
9	Fluorine (F)	5	+ 2	= 7	10	Neon (Ne)	6	+ 2	= 8	11	Sodium (Na)	7	+ 2	= 9	12	Magnesium (Mg)	8	+ 2	= 10
17	Chlorine (Cl)	9	+ 4	= 13	18	Argon (Ar)	10	+ 4	= 14	19	Potassium (K)	11	+ 4	= 15	20	Calcium (Ca)	12	+ 4	= 16
35	Bromine (Br)	23	+ 6	= 29	36	Krypton(Kr)	24	+ 6	= 30	37	Rubidium (Rb)	25	+ 6	= 31	38	Strontium (Sr)	26	+ 6	= 32
53	Iodine (I)	37	+ 8	= 45	54	Xenon (Xe)	38	+ 8	= 46	55	Cesium (Cs)	39	+ 8	= 47	56	Barium (Ba)	40	+ 8	= 48
85	Astatine (At)	63	+ 11	= 74	86	Radon Rn)	64	+ 11	= 75	87	Francium (Fr)	65	+ 11	= 76	88	Radium (Ra)	66	+ 11	= 77

indicated in Figure 4, a complete "Atomic and Nuclear Periodic Table of Elements and Beta-Stable Isotopes of Each Element" has been completed. It is expected to be commercially available in wall chart form in the near future.

*** A comprehensive paper entitled, "The Nucleon Cluster Model and the Periodic Table of Beta Stable Nuclides," is available from Clustron Sciences Corporation for a fee of $5.00 to cover reproduction and postage. This paper is also available on the world wide web at:**

http://www.gslink.com/~ncmcn/Clustron/

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A symmetrical relationship exists between gravity and force. The force/gravity relationship resembles the symmetrical electromagnetic relationship in many ways. One notable difference is the magnitude of the constants involved. The force/gravity relationship, as given by General Relativity, is expressed in equation #5.

$$F_g = G(dp/dt)/(c^2 r) \qquad \text{Eqn. \#5}$$

F_g = the gravitational field in newtons/kg
dp/dt = the change in momentum with respect to time (a force)

Equation #5 reveals that negative gravitational potential is also imparted to accelerating mass by the acceleration force. According to Mach's principle the force produced by a local acceleration is in reaction to this induced gravitational field. Mach's principle is stated in Equation #6.

Local force = Gravitational reaction Eqn. #6

$$(dp/dt) = M_u F_g$$

$$dp/dt = M_u G(dp/dt)/(c^2 r)$$

If Equation #6 is true equation #7 must equal 1.0.

$$M_u G/(c^2 r) = 1 \qquad \text{Eqn. \#7}$$

r = the radius of the universe
G = the gravitational constant
c = light speed
M_u = the mass of the universe

Amazingly, against all odds considering the magnitude of the numbers involved, Equation #7 is an identity. Positive kinetic energy and negative gravitational potential are simultaneously imparted to accelerating matter by the force of acceleration. This process holds the sum total of the energy in the universe exactly at zero.

THE ZERO POINT INTERACTION

After a sufficient amount of hydrogen is loaded into a "cold fusion" electrode, the hydrogen atoms begin to get buffeted around by the zero point vibrations intrinsic to the solid crystal lattice. In more exact terms, the zero point Fermi energy levels within the solid evanesce within a sea of dissolved hydrogen atoms. Forces are imparted by this interaction. These forces cannot transfer energy from the zero point system to the dissolved plasma. The zero point system is already in the lowest energy state. The system cannot drop to a lower energy state and shed any energy. The forces do, however, generate new energy through a process of genesis. Positive kinetic and negative gravitational potential are simultaneously produced. The process generates new energy and conserves energy.

COMMON OBJECTIONS

1. The gravitational field is very weak. It plays no role in atomic interactions.

True, the gravitational field is a weak translational force. Energy is the product of force and energy. The long range of the gravitational interaction compensates for its weak translational nature. Gravity is a potent energy exchange medium.

2. Distant regions of the universe are a long way off. Given that forces propagate at luminal velocities, these distant regions cannot be directly linked to local events.

Energy and momentum are carried by the induced field. The induced field acts as a reservoir of momentum and energy. After the field has reached distant parts of the universe this reservoir of momentum and energy is depleted. In the end, the books balance. Electrons are much smaller than a typical electrical circuit. Similar interactions balance momentum and energy in inductive circuits.

CONCLUSION

New scientific arguments have shown how something can be created out of nothing. These arguments have tremendous philosophical implications. If the creation process is now understood, can something now be created out of nothing? Inventors have been trying to do this for many years. In fact, the patent offices currently reject all applications for patents on such perpetual motion machines. If a gravity producing machine could be built, however, it would produce positive energy in an amount equal to the negative gravitational potential of the induced field. As of late, several scientists appear to have created something (energy) from nothing.[4] Among the most advanced is Dr. H. E. Puthoff at the Center for Advanced Study in Austin Texas and Dr. J. A. Patterson, inventor of Clean Energy Technology's cold fusion cell. Puthoff, in particular, is attempting to extract the zero point energy of matter. According to this author's theories [5], the theories of Hal Puthoff[6], and the theories of Andrei Sakharov [7], the the zero point energy of matter is intimately linked to its gravitational field. If the zero point energy of matter is extracted, a gravitational field will be produced. This gravitational field will reach out and retard the expansion of the universe. Some of the kinetic energy of the expansion of the universe will eventually be absorbed by this induced gravitational field. This energy will be locally available for use. We will have to wait and see what comes from these latest ideas. If man finally creates substance from nothingness, he will have ventured into a realm that was, since antiquity, reserved for God. The world and its ideas will then surely change

.

NOTES

1. Edward P. Tryon, *Nature*, VOL 246, December 14, 1973.
2. Technically, nothing can exist outside of the universe. The universe is a closed structure in which, according to the cosmological principle, all positions are equivalent. The model presented in this paper, in which an object falls from an infinite distance away to the edge of the universe, does not represent reality. The model does} however, allow for the calculation of the negative gravitational potential shared by all objects within the universe.
3. In 1933, Fritz Zwicky proposed that 90% of the matter in the universe is "dark." He came to this conclusion from the study of clusters of galaxies. In 1977, Vera Rubin confirmed that 9Q% of the universe's matter is composed of the so called "dark matter" from her study of the rotational speeds of galaxies.
4. A ball lightning experiment in Japan appeared to produce excess energy. Y.H. Ohtsuki & H. Ofuruton, *Nature*, VOL 246, March 14, 1991
5. Frank Znidarsic, ELEMENTARY A. GRAVITY Adventures Unlimited, Kempton Il. USA, 1989. "Antigravity on a Disk" Self published 1995.
6. Working with electron condensations.
Hal Puthoff, *Physical Review A*, March 1989.
Hal Puthoff, D.C. Cole, *Physical Reveiw E*, August 1993.
Hal Puthoff, *Omni*, "Squeezing Energy From a Vacuum" 2/91
7. Andrei Sakharov, *Soviet Physics Dockladi*, Vol 12, May 1968, Page 1040.

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COLD NUCLEAR FUSION AND ENERGY GENERATION PROCESSES IN TERMS OF THE SCHRÖDINGER EQUATION

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In earlier works [1,2] an approximate motion equation for an individual oscillating charge particle was proposed. It adequately explains both the cold nuclear fusion phenomena [13] and the anomalous excessive energy [12] occurrences of a mysterious origin being observed in experiments of a number of researchers. Yet, the said equation has resulted from purely heuristic reasoning, not in rigorous terms, when determining the electric charge value and the fine structure constant [9,10] on the basis of the Unitary Quantum Theory (UQT). This invited right criticism of many research workers and caused personal deep dissatisfaction. Further it will be shown that the above equation may follow directly from the Schrödinger equation for small energies.

Let us consider the entire Schrödinger's equation (1):

$$\frac{\hbar^2}{2m}\frac{\partial^2}{\partial x^2}\Psi(x,t) + i\hbar\frac{\partial}{\partial t}\Psi(x,t) = U(x)\Psi(x,t)$$

Its solution is to be expressed in wave function terms (2):

$$\Psi(x,t) = \cos(kx)\int \exp[tg(\phi)]dt$$

where

$$\phi = \frac{mt}{2\hbar}\left(\frac{dx(t)}{dt}\right)^2 - \frac{mx(t)}{\hbar}\frac{dx(t)}{dt} + \phi_0$$

(3)

where ϕ_0 is an initial phase, x is an independent varsiable, and x(t) represents a non-related to x as yet unknown function which, as will be shown below, turns out to be a time-dependent coordinate. By substituting the latter into the Schrödinger equation we arrive at (4):

$$i\hbar^2 k^2 \int \exp[tg(\phi)]dt + 2imU(x)\int \exp[tg(\phi)]dt + 2\hbar m \exp[tg(\phi)] = 0$$

At small energies the value $h^2k^2 << 2mU(x)$, the first integral being neglected. Having differentiated the resulting equation with respect to time and having reduced the common exponential factor we come to

$$2U(x)\cos^2(\phi) + 2mt\frac{dx(t)}{dt}\frac{d^2x(t)}{dt^2} - m\left(\frac{dx(t)}{dt}\right)^2 - 2mx(t)\frac{d^2x(t)}{dt^2} = 0$$

(5).

It is evident that for short time stretches (or for small energies at elastic interactions when the velocity changes are small) the member

$$x(t) = t\frac{dx(t)}{dt}$$

Then the second and third teerms are reduced and we obtain the following (6):

$$U(x)\cos^2(\phi) = \frac{m}{2}\left(\frac{dx(t)}{dt}\right)^2$$

It is clearly seen that the left term is the potential energy oscillating according to the harmonics law, whereas the right one represents the conventional kinetic eenrgy. Yet, the potential energy doesn't transform into the kinetic one as is the common case in the coservative systems of conventional mechanics. If one relates the potential energy oscillation s those of the electric charge existent in the Unitary Quantum Theory [3-1 1], as the potential energy always stands in direct proportion to the electric charge value, then one arrives at the oscillating charge equation of conventional mechanics. But ill this case one's reavow would naturally proceed from the necessary assumption on substitution of the independant variable x for the function x(t).

Proceeding from this equation, by way of differentiation, one can readily come to the same oscillating charge equation of motion, the latter having been obtained [1,2] heuristically within the Unitary Quantum Theory based on quite different reasons.

$$m\frac{d^2}{dt^2}r = Q\,\mathrm{GRAD}(U)\cos^2(\varphi)$$

where

$$\varphi = \frac{mt}{2\hbar}\left(\frac{dr}{dt}\right)^2 - \frac{mr}{\hbar}\left(\frac{dr}{dt}\right) + \phi_0$$

Let us clear up the validity of the resulting lst order equation (6). At first, we shall consider the motion within the plane condenser field. Let us insert the potential U(x) = Gx(t):

$$Gx(t)\cos^2(\phi) + \frac{m}{2}\left(\frac{d}{dt}x(t)\right)^2 = 0$$

(7)

We shall look for a particular solution in the form of $x(t) = at^2$ Having substituted this solution into the equation (7) we arrive at (8):

$$at^2\left(G\cos^2(\phi_0) + 2am\right) = 0$$

One can see clearly that the acceleration may be chosen to satisfy the equation. The motion will take place with the acceleration value of:

$$a = -\frac{G\cos^2(\phi_0)}{2m}$$

An interesting fact is discovered: the acceleration generated in one and the same field is dependent upon ... the initial phase ϕ_0.

Let us consider now the diffusion motion within the dipole field $U(x) = G/x(t)^2$, for which there is also a well-known analytical solution.

The substitution of the particular solution

$x(t) = r\sqrt{t}$ will result in:

$$\frac{1}{8tr^2}\left\{8G\cos^2\left(\frac{3mr^2 - 8\hbar\phi_0}{8\hbar}\right) + mr^4\right\} = 0$$

This transcendental equation will have a non-analytical decision, as the 4-th degree parabola will always intersect with the cosine squared. And again, the velocity of the resulting motion will depend upon the initial phase value ϕ_0. Unfortunately, at this point the possibility of solving these equatiom analytically seems to be exhausted.

In all the solutions the coordinate, velocity, or acceleration is always dependent upon the initial phase value ϕo. As illustrated by the given examples, at some phase values the motion equations are in conformity with the energy conservation law and are the same as within conventional mechanics, whereas at other phase values

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the motion will be different and, consequently, there is violation of the energy conservation law: the particle may gain or lose energy. The same phenomenon is true for the harmonic oscillator, which has been revealed at first numerically in [1,2], and both the cold nuclear fusion and the energy generation mechanisms in their considered approximation follow directly from the Schrödinger's equation. It is well-known that the energy conjuration laws are nonexistent if the potential function is time dependent. It should be noted that even in the conventional quantum mechanics the energy conservation laws are observed within the accuracy of uncertainty correlatlon. Previously it was shown numerically [1,2,3] that if one sums up the energy or momentum for an assembly f particles throughout all the phases, the resulting energy and momentum will be preserved, which is the case in quantum mechanics, because it always regards particle in assemblies.

The energy coservation laws hold true only in selection of the initlial phase particular value, which proceeds clearly from the equation's translation properties. Thus, the given examples prove the soundness of the earlier used approach and the validity of the oscillating charge motion equation, having been previously obtained heuristically on the basis of absolutely different assumptions.

We shall regard now the problem of the cold nuclear fusion. Let us express the equation of motion for two nucld Keith charges Q and q. Let the heavy nuclei possessing the charge q be at rest, and let the other nulceus move in its direction with the velocity V from the point at the

Restricting our consideration by the first three tenns of the obtamed distance A. Then the equation of motion for the head-on collision may be expressed in the following way:

$$m\dot{x}(t)^2 \frac{d^2}{dt^2} x(t) = Qq\cos^2(\varphi)$$

where (9):

$$\varphi = \frac{mt}{2h}\left(\frac{dx(t)}{dt}\right)^2 - \frac{m}{h}(x(t) + A)\frac{dx(t)}{dt} + \phi_0$$

The accurate analytical solution for the above equation is hardly possible, yet, one may obtain a 4-th order series expansion of its solution:

$$x(t) = A - Vt - \frac{Qq\cos(\phi)^2}{2mA}t^2 + \frac{QqW\cos(\phi)}{6A^2mh}t^3 + O(t^4)$$

where

$$W = -2hV\cos(\phi) - mAV\sin(\phi) + 4Qqh\cos^2(\delta)\sin(\phi)$$

$$\delta = 2\frac{mVA}{h} + \phi_0$$

Restricting our consideration by the first three terms of the obtained solution, we can find out that minimum x(t) occurs at:

$$t = -\frac{mVA}{2Qq\cos^2(\delta)}$$

Then the minimal distance for which the nuclei will approach each other will be equal to:

$$x_{min} = A - \frac{mV^2A^2}{4Qq\cos^2(\frac{2mVA}{h} + \phi_0)}$$

It is evident that by choosing the initial phase value at no matter how small energies and at any nuclei charge values, the minimal distance between the nuclei may be made no matter how small. This was shown numerically for the first time in [1,2]. Consideration of the next (cubic) component would not entail any principal changes in the solution and, therefore, is not cited herein because of its being too cumbersome. Such nuclei transmutations harve been frequently observed. It is clear now that cold nuclear reactions may take place at any nuclei charge values. Naturally, the phase precipice width [13] will diminish in direct proportion to the charge value increase.

The energy generation proceses may possibly help to explain the anomalous excess heat production phenomena occuring in proton conducting ceramics, CETI elements, nickel electrolysis in light water, cavitation bubbles, hydrated metals, fermentative chemical reactions, etc. In such systems the proton (or some other particle), being incorporated into some kind of cavity (potential well), will each time be reflected from its wall with the velocity greater than that of falling and take energy from the vacuum (the "maternity home" solution) [1,2]. It is most curious that if the magnetic momentum oscillates alongside with the electric charge (which, of course, must take place in UQT), then the solution of the problem of their orientation is reduced to similar equations and thus it makes possible to obtain energy from vacuum with the hep of permanent magnets. There is an impression that these phenomena are observed in experiments. If Nature is actually designed so that there are no energy conservation laws for an individual particle, but there is one for an assembly of particles, then the generation of pollution free energy may be viewrd as a relatively simple task both from theoretical and technical viewpoint as compared to hot nuclear fusion. Thus the mankind will be saved from energy shortages forever. Look for the detailed discussion of energy conservation problem in earlier publications [12].

I wish to express my gratitude toDr. Nataly Famina, a remarkable translator, and my colleagues V.Boichenko, V.Dzhanibekov and Prof. M. Mokoulsky. I also wish to thank Dr. Eugene F. Mallove for a lengthy scientific discussion at the Loews Hotel, Monto Carlo, Monaco during ICCF5.

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The Nature of the Energy-Active State in Pd-D

Edmund Storms, ENECO

Presented at II Workshop on the Loading of Hydrogen/Deuterium in Metals, Characterization of Materials and Related Phenomena. Asti, ITALY, Oct 11-13. 1995. **[Ed. Note: This conference, attended by some 40 scientists, was sponsored by Fiat Corporation.]**

ABSTRACT

Evidence is presented to show that the energy-active state is located within the surface of electrolyzed palladium. Although a high average D/Pd ratio is required to form this state, this is not the only condition. Several additional conditions must exist to cause a very high surface composition to form and to cause a conversion of the resulting material from β-PdD to another phase. The required high surface composition depends only in part on a high average composition. Absence of microcracks in the surface region, presence of surface and near surface impurities, and external energy application influence the eventual nucleation and growth of the required phase.

Cathode temperature is important because it influences the diffusion rates of deuterium and impurities consisting mainly of lithium. This property combined with the applied current and the eventual lithium content, determine how steep the deuterium concentration gradient will be between the surface and the interior. The steeper the gradient, the higher the surface composition for the same interior composition. This surface composition affects the amount and composition of the new phase. Both of these aspects determine the magnitude of power production.

1. INTRODUCTION

A major issue in understanding the cold fusion effect is to discover where the nuclear-active state (NAS) is located and its properties. Only with this information can proper models be developed and methods to enhance its formation be discovered. To complicate the situation, the NAS is different in different materials and when subjected to different conditions. This paper addresses the NAS that is produced in palladium when it is electrolyzed in an electrolytic cell containing $LiOD-D_2O$ electrolyte.

I suggest the NAS exists just below the surface of the Pd cathode and that the material is not β-PdD. Therefore, the properties of β-PdD are irrelevant to any understanding of the phenomenon. The properties of the underlying β-PdD are only important to the extent that they support the necessary conditions at the surface. This paper will attempt to justify these suggestions.

Three major factors affect the production of the NAS. These are the presence of cracks within the palladium structure that communicate with the surface, the presence of a lithium alloy region below the surface, and the presence of a diffusion barrier on the metal surface. These conditions combine to determine the deuterium concentration in the surface region. The value and location of this composition gradient structure determine the overall amount of NAS that will form and its general location. Other factors such as local dislocations, local concentrations of impurity, and local crystal size and orientation play a role in determining exactly where the NAS first forms. These latter variables will not be addressed in this paper.

Because the NAS is located on the surface and represents only a very small part of the total quantity of hydride, methods are needed that examine only the surface region. This work relies on the open-circuit voltage generated by the cathode with respect to a deuterium saturated platinum electrode. This voltage is proportional to the average deuterium activity within the outermost region of the surface. In addition, the value is proportional to the deuterium content of this region. Unfortunately, the exact correspondence between the voltage and these quantities is not known. The work will address this problem.

The approach combines previously published information, newly obtained results, and proposed structures in order to suggest a new approach to understand processes that effect formation of the NAS. The experimental details and additional results will be published in subsequent papers.

First, let us examine the variables that influence how palladium reacts with deuterium within an electrolytic cell.

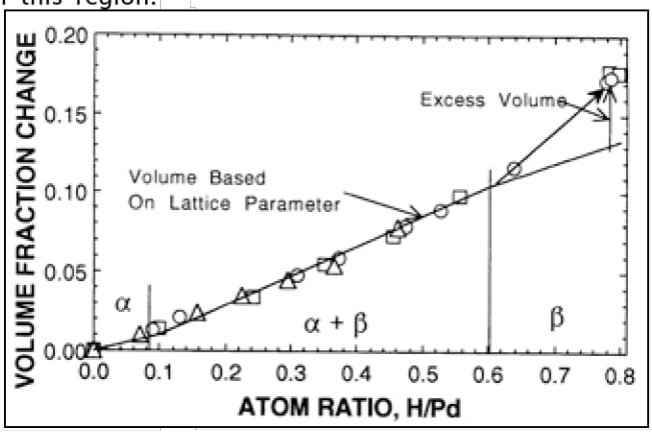
II. EXPERIMENTAL

II.1. Excess Volume

Most palladium contains defects that result in microcracks and voids upon its conversion to the hydride. The average volume associated with these cracks can be quantified by measuring the excess volume (EV)[1]. Figure I compares the measured volume change with the expected volume change calculated using the published lattice parameter. EV is produced only after the hydride enters the β-phase. This excess remains when hydrogen is removed and increases each time the sample reenters the β-phase. No additional excess is produced if the sample is deloaded and reloaded while remaining in the β-phase. Most palladium produces 3%-7% excess volume. Only a small number of samples produce no excess. Once formed, this excess can not be reduced by high temperature anneal.

Part of the EV consists of cracks that provide an escape path for hydrogen. This loss limits the maximum average composition that can be achieved. An example is shown in Fig. 2 where a sudden increase in EV resulted in a loss of hydrogen. Samples containing an initially high EV will not load to high compositions. This behavior can be seen in Fig. 3 where the relationship between EV and the maximum D/Pd ratio achieved after loading for 10 hr. at 250 ma is shown. These

FIGURE 1. Volume fraction increase as a function of composition



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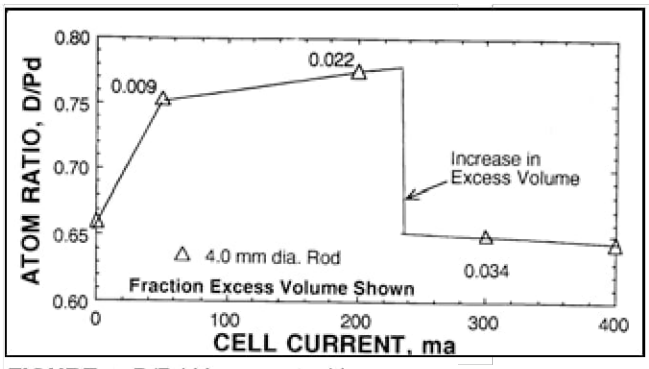

FIGURE 2. D/Pd Vs current with excess volume shown.

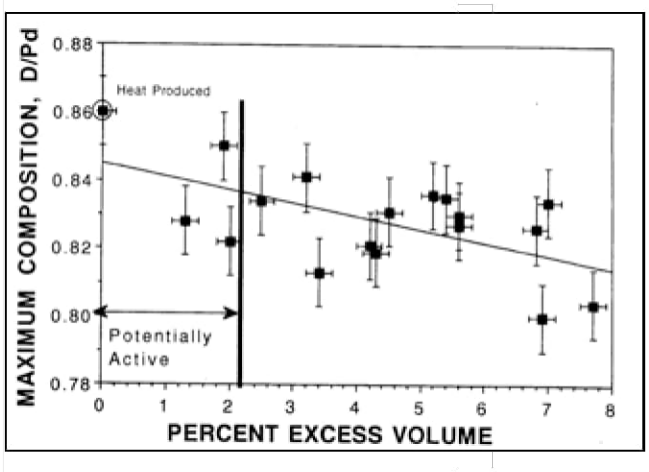

FIGURE 3. Maximum achieved D/Pd compared to the measured excess volume. The excess volume region proposed to allow excess energy production is indicated.

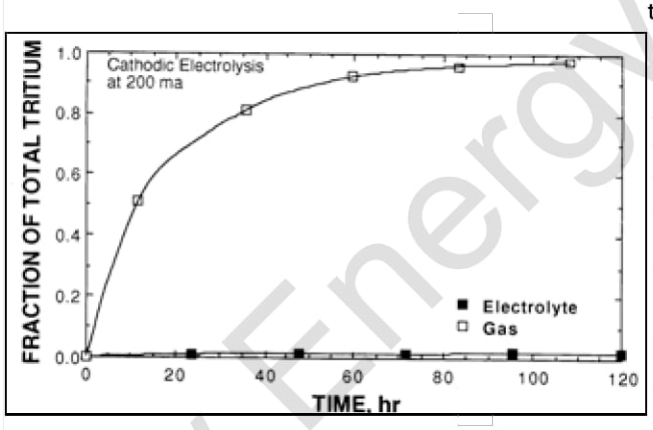

FIGURE 4. Fraction of tritium lost into gas and electrolyte during cathodic electrolysis

conditions are sufficient to produce a composition that is relatively constant with time. Although some samples will slowly go to higher compositions if electrolytic action is continued, this short-term loading condition is sufficient to show the effects being discussed in this paper. The relationship shows considerable scatter because the magnitude of the effect on the limiting composition depends on the fraction of the EV that communicates with the surface. This fraction is unique to each sample. In addition, this fraction frequently increases as the composition is increased. As a result, measurement of EV provides only a rough, but useful, method to identify potentially active samples.

II.2. Mechanism of Hydrogen Loss

The mechanism of hydrogen loss can be identified and the loss rate can be quantified by using tritium as a tracer.

A piece of palladium is electrolytically loaded with hydrogen containing a known amount of tritium. The loaded electrode is placed in an electrolytic cell that contains no initial tritium. The tritium content of the electrolyte and the evolved H_2 is measured. As shown in Fig. 4, most of the tritium, hence dissolved hydrogen, appears in the gas.

The hydrogen isotopes have two routes by which they can leave the palladium, either through the electrolyzing surface or out of cracks that communicate with the surface. Any tritium that attempts to leave through the electrolyzing surface is expected to quickly exchange with H^+ and OH^- ions in the solution and become trapped in the electrolyte. Only those hydrogen atoms that form HT or H_2 gas on an interior surface would be found in the gas. This behavior demonstrates that the evolving hydrogen gas is formed within cracks, out of contact with the electrolyzing surface. Thus, a hydrogen flux enters the palladium through the electrolyzing surface and leaves through interior cracks. Of course, a significant part of the available hydrogen does not enter the palladium at all but converts directly to H_2 at the surface. This hydrogen has no effect on tritium removal.

The data in Fig. 4 is replotted in Fig. 5 to show that tritium loss is a first order process, i.e. the loss rate is proportional to the tritium concentration. This behavior means that an average hydrogen atom resides for a definite time within the palladium. The half-life of a hydrogen atom in the palladium used during this study fell between 12 hr and 24 hr, depending on the applied current and the amount of EV. Temperature would also play a role but this variable was not explored.

II.3. Open Circuit Voltage Measurements

The open circuit voltage (OCV) developed between the cathode and a stable reference electrode is proportional to the activity (Gibbs Energy) of hydrogen dissolved in the surface phase. Accurate measurements can be made while the electrolytic current is interrupted for a brief time. Once calibrated, this quantity can give the actual composition of the surface. A rough calibration can be obtained by comparing the OCV to the average bulk composition. Provide the gradient is small, the relationship will show an upper limit to the voltage with respect to composition within the -phase.

The relationship between the average composition, obtained from the weight change, and the voltage referenced to a deuterium-saturated platinum electrode is shown Figure 7. The phase boundaries are drawn to be consistent with published information. The data shown in this figure are preliminary and describe a sample that has been electrolyzed for sufficient time to acquire a surface layer of a Pd-Li-D alloy. Although the behavior does not represent the pure Pd-D system, it does describe a typical sample used to produce excess energy by this technique.

When a sample has reached the conditions required to produce excess energy, the OCV rises abruptly from 1.1 V to near 1.4 V. The material having this voltage (D activity) can be decomposed by turning off the current. Figure 8 shows the voltage change during the deloading process following current interruption. The behavior suggests the presence of a new phase (γ) having a deuterium composition and activity significantly above that of the β-phase. A slight undershoot precedes decomposition of this phase into the β-phase. This behavior indicates that the γ-β transition requires a significant activity

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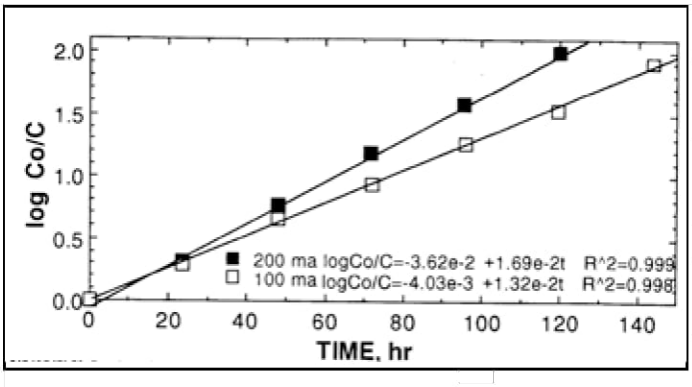

Figure 5. Plot showing first order loss of hydrogen from palladium being electrolyzed at two different currents.

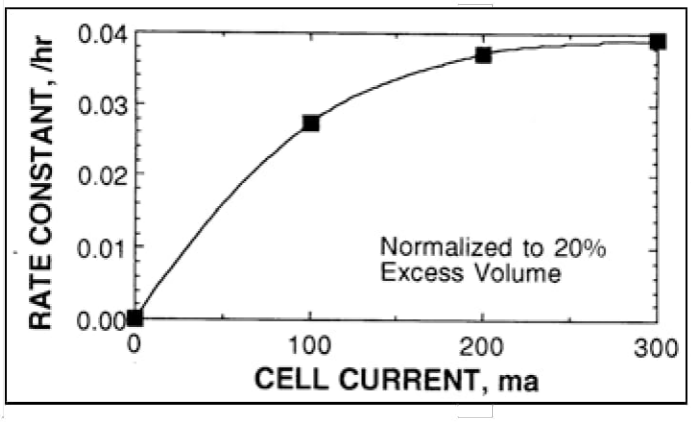

Figure 6. Effect of applied current on the rate constant at a fixed EV.

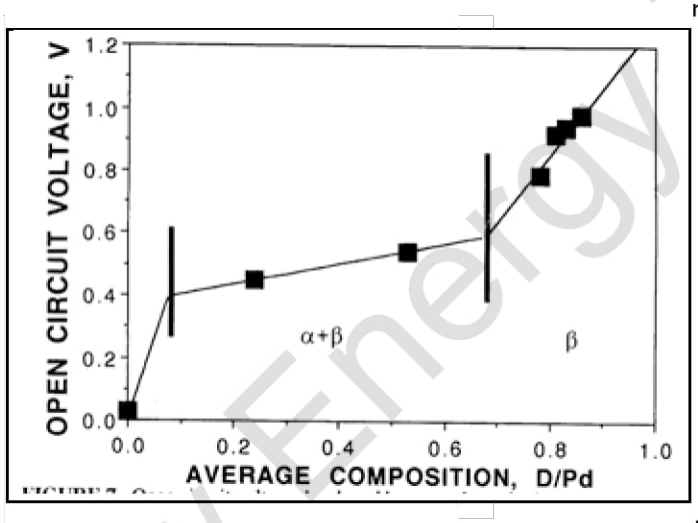

FIGURE 7. Open circuit voltage developed between the cathode and a platinum electrode located outside the cell.

difference to be initiated. An increase in activity is seen during the initial temperature drop indicating that the γ-phase becomes more stable as temperature is reduced. The structure and properties of this phase would be influenced by the proposed lithium content.

II.4. Proposed General Behavior

All of these observations can be explained if a gradient structure exists between the surface and the cracks. A diagram proposing how a crack affects the hydrogen gradient is shown in Fig. 9. Once established, this gradient would gradually change as lithium is deposited on the surface and is diffused into the interior. [2,3,4] The slowly growing complex layer of various possible Pd-Li-D phases (Pd_7LiD_x. Pd_2LiD_x, $PdLiD_x$, $PdLi_2D_x$, and $PdLi_3D_x$) would lower the diffusion rate through this region resulting in a steeper hydrogen gradient. The hydrogen and lithium compositions within this region is proposed to gradually rise and eventually reach the critical value needed to form the NAS. Although evidence is not yet available to completely support this model, I suggest that a search for such evidence would be worthwhile.

A coating of other impurities also forms which blocks both deuterium entry and exit from the surface. These impurities include Zn, Cu, Fe, Pb, Ca, Na, Mg, Pt, Cr, Si, S, and C,[5,6,7,8] with a complex morphology and distribution. Formation of the NAS depends on which of these two blocking processes has the upper hand. Because the loss rate through cracks can not be blocked, the hydrogen content within a sample having a high EV will be reduced as hydrogen uptake is reduced by a blocking layer. Only samples having zero EV will be helped by this barrier as hydrogen loss is reduced.

Such layers have been proposed to affect the D_2 dissociation reaction by either preventing D recombination to the molecule or reducing the availability of D ions on the surface. The net effect of either process would appear as a net increase or decrease in the gross loss rate. This mechanism is not addressed in this study.

Localized cracks can grow in the surface region because of stress within the brittle impurity layers. These escape paths can result in a surface composition too low to form the NAS even though the average composition is high. Because of their limited range, an increase in the average EV would not be observed. Excessive deloading after the lithium containing layer has formed followed by reloading is expected to produce such cracks.

II.5. Deloading Rates

It is possible to measure the deuterium loss rate through this barrier by assuming that this loss rate is independent of electrolyte action. If this assumption is correct, the barrier effect can be measured by allowing PdD to deload in air or within the cell.

An example of such deloading is shown in Fig. 10. A change in deloading rate is seen when the bulk composition reaches a value that allows α-phase to form on the surface. Only the loss rate within the β-phase is of interest here.

The deloading rate is influenced by the amount of EV, as shown in Fig. 11. To make this comparison, the final composition is shifted in time so that the final composition - time relationship falls on the line. In this way, a compensation can be made for the tendency to deload faster at higher compositions. The figure shows that a rapidly increasing deloading rate as the composition is increased prevents samples having high EV from achieving a high composition. Apparently, the cracks become more effective as the composition. hence internal pressure is increased.

III. CONCLUSION

III.1. Speculation About the Nature of the NAS

The NAS involves a phase having a higher composition and a much higher hydrogen activity than found in β-PdD. Although a variety of phase structures are available to explain this phase, I propose that the new phase relates to the β-phase as shown in Fig. 12. The new phase, designated gamma (γ), is formed as single deuterium atoms within the fcc structure

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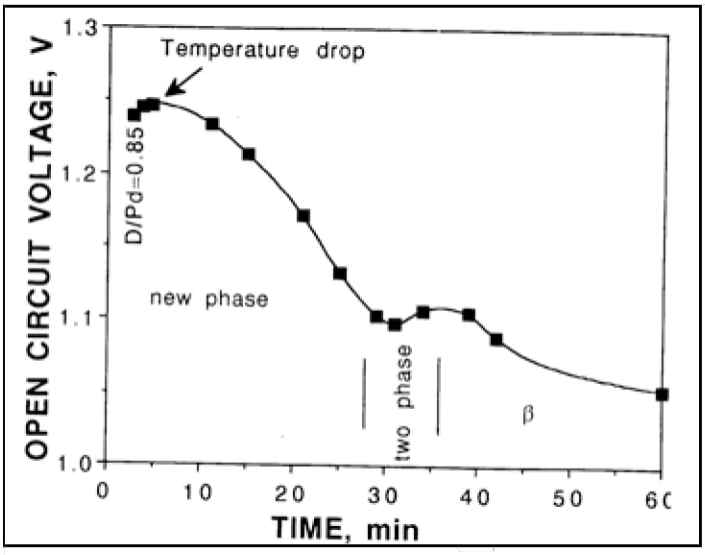

Figure 8. Voltage change during deloading in the cell. The temperature dropped from 22° to 9° C during the first 5 minutes. The initial average bulk composition is shown.

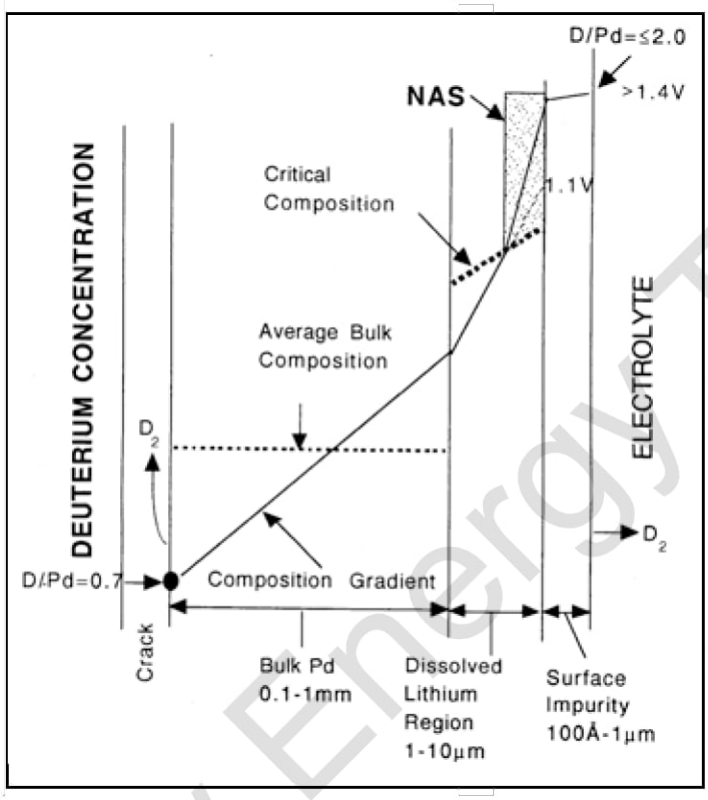

FIGURE 9. Concentration gradients in the various regions between the electrolyzing surface and an interior crack. The various measured OCV are shown. The nuclear-active state is designated by NAS. The thickness and composition scales are arbitrary. The complex phase structure within the "dissolved lithium region" is not shown.

of β-Pd (Li)D are replaced by D_2 dimers. A cut through the [100] plane of the proposed fcc structure is shown in Fig. 13. In addition, the dimers may interact to produce an ordered structure leading to a slight modification of the cubic lattice. Ordering of the Li atoms would have the same effect.

This dimer structure is proposed to form by covalent sharing of one electron between two deuterium atoms. The other electron is contributed to the conduction band of the palladium structure. This phase is expected to have a very low diffusion rate for hydrogen as well as other unusual properties.

In an electrolytic cell, the NAS also contains Li atoms. The resulting structure will be modified by the presence of this impurity. How this modification affects the stability or structure of the γ-phase is unknown. These lithium atoms are not proposed to participate in the nuclear reaction but only aid in creating the necessary chemical (electron) environment in which nuclear reactions might occur. This is not to say that the Li atoms as well as other impurity atoms would not participate in a nuclear reaction once the NAS forms.

III.2. General Conclusions

Formation of the NAS in a Pd-D electrolytic cell is affected, at least in part, by the following factors:

1. Concentration of microcracks in the cathode. (The palladium purity has a direct effect on this factor.)
2. Applied current between limits. (These limits will be affected by the number of cracks that reach the surface.)
3. Temperature of the cathode. (This factor can be influenced by the amount of applied current.)
4. Presence of surface barriers on the cathode. (The effect will depend on the number of cracks that reach the surface.)
5. Presence of lithium within the surface region. (The loading time and temperature have a direct effect on this factor)
6. Crystal size and orientation. (Annealing has a direct affect on this factor.)
7. Application of energy to the lattice to aid in the β-γ conversion. (This energy can take various forms including RF, magnetic, sonic and optical.)

All of these factors impact on the ability to achieve high, local concentrations of deuterium. The presence of impurities unrelated to producing a high deuterium concentration have unknown but probably important influence on the stability of the γ-phase.

Because of a very low diffusion rate, once formed, the NAS can remain metastable for a period of time after the electrolytic current is stopped. It lasted for about 60 minutes in this study. However, it will eventually decompose when the surrounding deuterium concentration drops below a critical value. The lifetime will depend on how fast the NAS loses deuterium, on the presence of nucleation sites to allow to conversion, and on the amount of lattice destruction caused by nuclear energy release while at the nuclear-active composition. These factors give some hope for an eventual determination of the crystal structure for this phase.

Because the NAS is not within the β-phase, theories and models based on the atom environment or thermochemical properties of the β-phase have no merit. The proposed phase offers the possibility of fusion involving 4 atoms of deuterium, i.e. 2 dimers, as suggested by Takahashi.

Minor variations in the NAS would appear to have important consequences because a variety of nuclear reaction products are occasionally seen. Consequently, the proposed model adds an unanticipated complexity to any theoretical approach.

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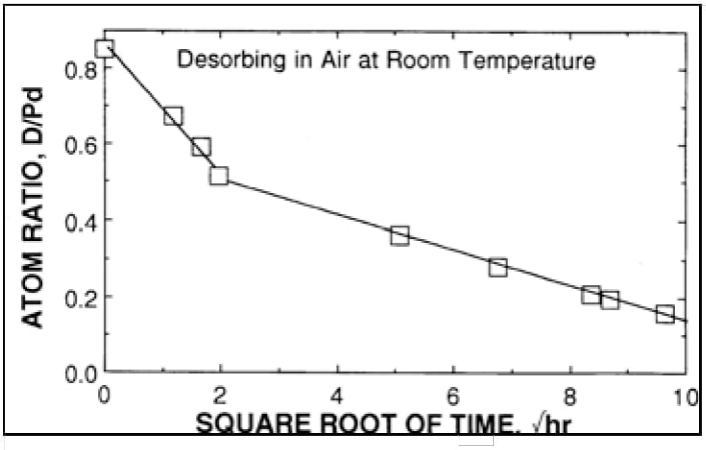

FIGURE 10. Composition of a typical PdD sample shown as a function of square root time while deloading in air.

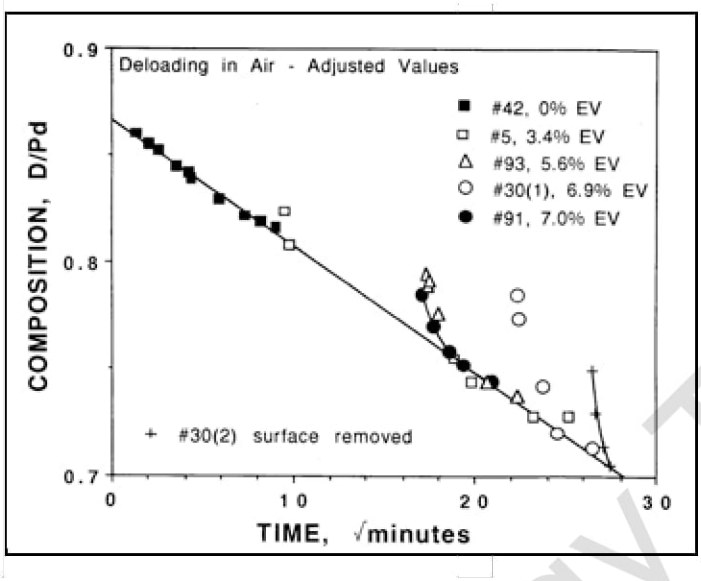

FIGURE 11. Deloading rate in air compared. The composition is adjusted in time to make the final deloading slope fall on the line. The curves terminate at the highest composition achieved during loading.

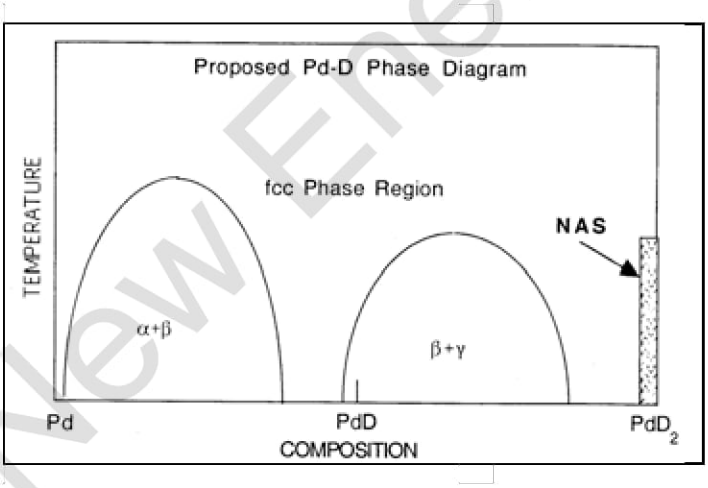

FIGURE 12. Proposed phase relationship in the Pd-D_2 system.

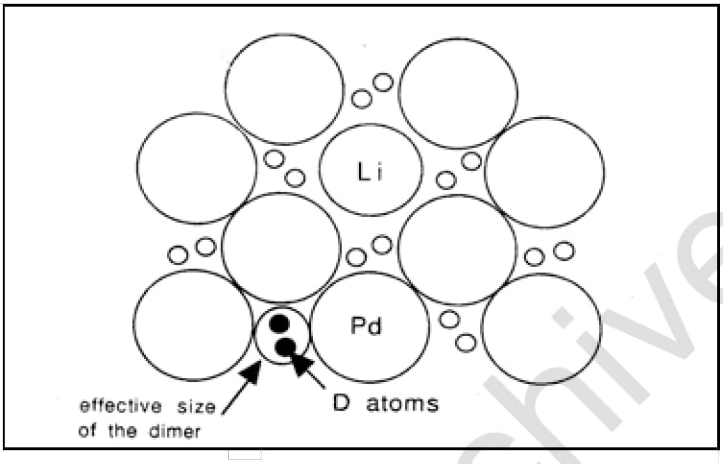

FIGURE 13. Diagram of the {100} face of fully occupied (fcc) γ-Pd(Li)D_2.

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Zero-Point-Field-Induced Inertia and Gravitation: Questions, Answers and Issues

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PREFACE

When Eugene Mallove asked whether the following document could be published in this magazine, I was initially reluctant since this is an informal write-up, not a carefully prepared article; moreover it does not concern itself with so-called cold fusion. Like many scientists I am suspending judgement concerning gadgets that seem to tap some heretofore unrecognized energy source until such time as the long-promised commercial devices actually become available: that would be the proof of the pudding. However I was persuaded by Mallove's argument that mainstream scientists (of which I am one!) may be unduly resistant to questioning fundamental assumptions, and that these new theoretical ideas of mine and my colleagues may provide a useful example of both the questioning and the resistance.

I did not set out to question fundamental physics assumptions. For some 20 years I have been engaged -- and continue to be engaged -- in basic research in the area of solar-stellar astrophysics. My contributions to that field have been fruitful but certainly not revolutionary. The rewards have been the usual ones in mainstream science: recognition of expertise and establishment of a reputation within an international community of researchers. On the basis of that I compete for and am selected to use NASA orbiting observatories, am given the honor of presenting invited reviews of the field at conferences and in journals from time to time (see for example ``Advances in Solar-Stellar Astrophysics'' in the February 1996 *Publications of the Astronomical Society of the Pacific*), succeed in publishing research papers, and serve as a scientific editor of the *Astrophysical Journal*, the leading publication in that field.

In addition to all that, though, I now find myself involved in the development of controversial ideas that certainly would be revolutionary if true: that both inertia and gravitation may be electromagnetic phenomena, that Newton's equation of motion might be derivable from Maxwell's equations. It was rather an accident that all this came about and were it not for the expertise of my colleague Prof. Alfonso Rueda in this field, the idea that inertia might be due to the zero-point field (which occurred independently to Puthoff as well) would have almost certainly remained an idle speculation. But this speculation has now been developed into a bona-fide quantitative concept (though certainly not yet a proven one), and a different kind of ``reward'' has accompanied that: accounts in the media, letters full of questions and fanciful ideas, etc. My attempt to deal with such demands in a way that would be constructive and fruitful rather than a drain on my time and energy led to my initiating the following document which has until now been merely circulated privately to interested parties.*

*[Readers interested in following up on this further may write or send me email to request a preprint of the article ``Physics of the Zero-Point Field: Implications for Inertia, Gravitation and Mass" by Haisch, Rueda and Puthoff to appear in *Speculations in Science and Technology*.]

RATIONALE

Following the publication of *Inertia as a Zero-Point Field Lorentz Force* in *Physical Review A* in February 1994 and the writeups in *Science* (Vol 263, pp. 612--613), *Scientific American* (Vol. 270, pp. 30--31), *New Scientist* (25 February 1995, pp. 30--33), various newspapers and elsewhere, considerable correspondence has been received consisting of questions and other theoretical propositions, some substantive, some not. Colloquia were also presented (at U. C. Berkeley, Stanford Univ., San Francisco State Univ., The Heisenberg Institut--Munich, Max-Planck-Institut für Extraterrestrische Physik--Garching, Oxford Univ., Univ. of London--Queen Mary College, Univ. of Birmingham, Lockheed) and these too led to numerous questions. The following writeup consisting of ``questions and answers" and ``outstanding issues" is (1) an attempt to provide responses in a coherent format; (2) a way to explore and develop the ramifications of the zero-point field ideas; and (3) an education process for the author. It should be viewed as a ``working document" that will evolve with time and in which the answers may change. Some of the following is of necessity speculative. Moreover the questions range from the superficial to the profound; a similar range should apply to the answers, though unfortunately not necessarily in proportion.

— What is the problem with inertia that this concept seeks to address?

Newton's second law states: $\vec{F} = m\vec{a}$

The resistance to acceleration of a material object is a measure of its mass. In fact, it is more true to say that this is a definition of mass, specifically inertial mass, m_i. Gravitational mass, m_g, is defined in terms of the Newtonian gravitational force, or in general relativity, in terms of space-time curvature. The principle of equivalence postulates the equality of the masses: $m_i=m_g$. It has been assumed that m_i is an innate property of matter, but since it is defined as a resistance to acceleration, the issue is ``acceleration with respect to what?'" Newton assumed the acceleration was with respect to a universal frame of rest: absolute space.

Why is the rotation of the earth with respect to a Foucault pendulum the same as the rotation of the earth with respect to the ``fixed stars"? That the stars happen not to be rotating with respect to the Foucault pendulum plane at the pole is strong evidence of a linkage between the matter in the universe and the local property of inertia, a view that has come to be called Mach's principle. In his general theory of relativity, Einstein attempted to incorporate the Machian view so that the gravitational influence of the whole universe would give rise to the inertia of a particle of matter at any given point. As Einstein himself admitted, GR failed to do this (cf. Sciama 1953, p. 35): ``Einstein showed that his field equations imply that a test-particle in an otherwise empty universe has inertial properties." In 1949, mathematician Kurt Gödel found a solution to Einstein's equations for a rotating universe. This would also be meaningless if the totality of the uni-

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verse defined a rest frame (see discussion in Davies 1988); how could the universe rotate with respect to a frame that it itself defined?

As emphasized by Brans and Dicke (1961), since the time of Descartes there have been only two ideas concerning the nature of space: either space is an absolute physical structure with definite properties even in the absence of any matter (the Newtonian view), or the geometry and the inertial properties of space are determined by the distribution of matter without which space would have no properties (the Machian view). The Machian view implies, as stated by Sciama (1953): ``If the rest of the universe determines the inertial frames, it follows that inertia is not an intrinsic property of matter, but arises as a result of interaction of matter with the rest of the matter in the universe.'"

While it appears that Sciama (1953) provided an excellent basis for quantifying Mach's principle, there is still no accepted rigorous formulation of Mach's principle (see ``Doubts about Mach's Principle" by McCrea 1971; ``Einstein and Mach's Principle" by Barbour 1988). We propose in place of Mach's principle of matter-matter interactions that inertia is due to interaction between matter and the ZPF.

The linked concepts of ZPF-induced inertia and gravitation, if true, would accomplish four things: (1) eliminate the property of innate inertial mass and replace it with a specific electromagnetic force acting between the ZPF and the charge underlying matter; (2) establish the ZPF as the required reference frame for acceleration (since the ZPF is Lorentz invariant there is no conflict with relativity of unaccelerated motion required by special relativity); (3) provide a physical explanation for the equivalence of inertial and gravitational mass; and (4) unite gravitation with the electromagnetic force.

— ***Issue: Problems with Mach's Principle as Developed by Sciama (1953).***

Sciama (1953) proposed that in addition to the scalar gravitational potential,

$$\Phi = -\int_V \frac{\rho}{r} dV$$

there was also a vector gravitational potential having physical significance,

$$\vec{A} = -\int_V \frac{\vec{v}\rho}{cr} dV$$

He was able to derive an inertia term from the gravitational induction arising from

$$\vec{A} \ .$$

In this view matter collectively induces inertia, with distant matter contributing the most since in a homogeneous universe $d\Phi/dr \propto r$. This formulation of Mach's principle by Sciama leads to three predictions: (1) a relation between G and ρ_m, the mean density of matter in the Universe; (2) the relation $G\rho_m\tau^2 \sim 1$, where τ is the age of the Universe; and (3) a contribution on the order of 10^{-7} for the Milky Way to the local inertia. The second prediction would imply a G decreasing with time, since for a linearly expanding universe, $\rho \propto \tau^{-3}$. The third prediction would appear to imply an asymmetry in inertia, i.e.

$$m_i = \vec{m}_i$$

Several experiments summarized in Weinberg (1972) rule out inertial asymmetry at the level $\Delta m/m \leq 10^{-20}$.

— ***Issue: Discrepancy between Mach's Principle and General Relativity in Lense-Thirring Effect.***

In the Machian view, all external matter makes a contribution to the inertia of an object. Thus the earth contributes to the inertia of any object, though in a very small way (about 10^{-9} in the formulation of Sciama 1953) since it is distant matter that contributes the most. The fact that the earth is rotating with respect to the other external matter creates the effect of frame dragging: the Lense-Thirring effect. This is the smaller of the two effects that the NASA-Stanford Gravity Probe B experiment is designed to measure, amounting to ~0.042 arcseconds per year. Rindler (1994) has recently shown that general relativity is inconsistent with Mach's principle: GR predicts that a gyrocompass will precess in a direction opposite to that predicted by Mach's principle No calculation has been done yet to examine whether the ZPF model makes the same prediction as GR.

— ***Is the ZPF the same thing or related to the Cosmic Microwave Background (CMB) in which fluctuations were finally discovered by the NASA COBE satellite in 1992?***

No, the ZPF and the CMB are not related. The CMB has a feeble 2.73 K Planckian spectrum; the ZPF has a non-thermal ω^3 (frequency-cubed; ν^3 where $\nu=\omega/2\pi$) spectrum which is speculated to cut off at the Planck frequency: $\nu_P = 1.86 \times 10^{43}$ Hz.

— ***If the ZPF has nothing to do with the Cosmic Microwave Background, where does it come from?***

It is postulated that the ZPF is just part and parcel of the Universe. Presumably it originated together with the rest of the Universe. This same question can be phrased in a more rigorous (albeit fundamentally no more substantive) way in terms of boundary conditions on Maxwell's equations of electrodynamics, and this is discussed by Boyer (1975). \

Puthoff (1989a) proposed a kind of cosmological feedback model in which quantum motions generate zero-point fields, which in turn generate particle motions. In this sense the present state of the Universe is an excited state of sorts. An interesting consequence of this approach is that it leads to a relationship of Hubble length to electron size, one of the ``cosmological coincidences" often discussed in the context of Dirac's large-numbers hypothesis. This analysis has been criticized by Wesson (1991) and Santos (1991). My interpretation is that the Puthoff analysis does not address the origin of ZPF radiation; rather it shows that the scattering of ZPF radiation by charged particles is a detailed balance process. However the connection with Dirac's large numbers may be significant.

— ***Does the Hubble expansion produce a redshift of the ZPF and would this not change inertia and gravitation as the Universe evolves?***

The ω^3 ZPF spectrum is the unique spectrum that remains invariant under an adiabatic compression or expansion of a cavity (Rueda 1981, p. 2021), thus should not change. This spectrum is unique in being Lorentz invariant.

— ***What justification is there for postulating the existence of a real ZPF?***

One of the goals of stochastic electrodynamics is to attempt to derive quantum laws using only classical

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physics *plus* a real ZPF. This has been partially successful so far. It is unknown at this time whether all quantum laws can be obtained from classical physics plus a ZPF. If it proves to be possible to do so, we will have a choice. A complete description of the physical universe could then be provided by classical physics plus quantum physics (having quite distinct laws and logic) or by classical physics plus a real ZPF (together called stochastic or random electrodynamics, since the ZPF can be characterized as plane waves completely random in direction and phase). Postulation of the existence of either a real ZPF or of quantum laws would then be on a par with each other.

– What does Stochastic Electrodynamics (SED) consist of?

Classical electrodynamics of charged point particles consists of three elements (Boyer 1975): (1) Newton's laws of motion for particles; (2) Maxwell's equations for the electromagnetic fields; and (3) boundary conditions for both. Classical electrodynamics takes as its electromagnetic boundary condition that all electromagnetic fields originated in some physical process such as the Big Bang or subsequent circumstances such as thermonuclear energy generation in stars or the heating of a filament in a lightbulb, for that matter. Stochastic electrodynamics assumes that there is, in addition, a uniform, isotropic background electromagnetic zero-point field. Moreover it now appears that Newton's laws of motion may be derivable from Maxwell's equations if one includes the ZPF.

— Is the ZPF a form of light?

If the term *light* is generalized to include electromagnetic radiation at all other wavelengths ranging from radio waves to gamma-rays and beyond, then the ZPF can be said to be a form of light having a particular and unique spectral distribution. It has been noted that many metaphysical traditions postulate an intimate relationship between light and the creation of matter (e.g. *Genesis*), however speculation of this sort is beyond the scope of physics.

— The inertia-causing process involves the interaction of the ZPF and charge, so how would a neutral particle like the neutron acquire inertia?

The interactions would take place at the quark level in baryons. The ZPF would interact with the three (udd) quarks of a neutron in the same way as with the three (uud) quarks of a proton. Owing to the nature of the strong interaction increasing with distance (opposite to the behaviour of the Coulomb force), at very high frequencies each of the three bound quarks would effectively act as independent particles for ZPF-driven oscillations. As summarized by Lindley (1994, p. 118): ``At close range quarks barely notice one another's presence and act like independent particles.'' The electron appears to be a fundamental particle and would directly interact with the ZPF as a single charged particle.

— Wouldn't a real ZPF create, effectively, a huge cosmological constant?

If inertia originates in ZPF-charge interactions, then gravitation must have a similar origin since inertial mass and gravitational mass are intimately linked by the principle of equivalence. A ZPF model of gravitation was proposed by Andrei Sakharov in 1968. Its first quantitative development was by H. E. Puthoff in 1989, although this too is only a preliminary model which has been criticised by Carlip. However in this approach, gravitation is seen as an electromagnetic force originating in asymmetries (strictly speaking, correlations; see below) of the ZPF in the presence of matter. The ZPF causes a charged particle to oscillate. Oscillating charged particles generate their own electromagnetic fields. An adjacent particle will thus experience both the ZPF and a secondary field caused by the driven oscillations of the first particle. This secondary field appears to give rise to an attractive force which is intepreted as gravitation. In this view, the ZPF *cannot* itself gravitate since gravitation consists of these secondary field or equivalently gravitation consists of asymmetries in the ZPF. The energy density of the ZPF could *not* be a source of gravitation. This view is of course significantly different from that of conventional general relativity, but the ZPF-based inertia and gravitation concepts are self-consistent.

— The Puthoff analysis of the absorption and reemission of ZPF radiation by charged particles found that process to be one of detailed balance. Does this not contradict the ZPF-gravitation interpretation in which a given particle creates a kind of asymmetry in the field giving rise to a force which can be interpreted as gravity?

No, there is not a conflict between detailed balance, and yet at the same time developing an asymmetry that leads to an attractive force. Any given dipole absorbs and re-emits the ZPF so as not to change either the frequency or spatial distribution. The same is true for a neighboring dipole. However, since each dipole does sees the (undistorted) emission from the other, the two can become (retarded) phase-locked such that the fields, though unchanged in magnitude, can become correlated in phase. Being so correlated they partially cancel, thereby reducing the overall integrated field energy, and the force goes as the negative gradient of that energy. Thus the attractive force is not a result of *distorting* the distribution of dipole fields so as to make them asymmetric, but as a result of *correlating* undistorted fields. (Note that in the mathematical development each individual dipole's field is assumed to continue to be undistorted: They just become correlated, and the attractive force is the gradient of a correlation energy.)

— Does this imply that space is not curved after all?

The exploration of a ZPF model for gravitation has just begun. No one disputes that the mathematical description of gravitation can be done in terms of space-time curvature. It is assumed that the mathematical description corresponds to physical reality. Tests of relativity are naturally taken as confirmation of the validity of the non-Euclidian space-time concept since there has been no credible alternative. It *may* be that variations of the dielectric properties of space vis-a-vis the ZPF can be expressed in a way that is mathematically equivalent to the curved space-time of general relativity.

Furthermore two points are worth making about relativity as stated by Lindley (1994). (1) General relativity is ``even today one of the least well-tested of physical theories" and is ``a theory whose wide acceptance owes at least as much to it overwhelming conceptual power as to any empirical support." (2) ``The contradictions between relativity and quantum mechanics constitute the single great question in fundamental physics today." It is suggested that a ZPF-based model is not in conflict with

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observational evidence in favor of general relativity and that the desired resolution of general relativity and quantum mechanics would follow automatically.

In Einstein's early investigations of gravitation he did not assume that space was curved; instead he assumed that the speed of light was a function of gravitational potential. This is expressed in equation (3) of his ``On the Influence of Gravitation on the Propagation of Light'' (*Annalen der Physik*, 35, 1911) in which he writes

$$c = c_0\left(1 + \frac{\Phi}{c^2}\right)$$

where Φ is the gravitational potential. The two assumptions in this early study of gravitation were that the gravitational potential altered clock time and the speed of light. In its final development the speed of light was assumed to be a constant --- as in special relativity --- and to make this self-consistent the concept of space curvature was introduced. It may be worthwhile to further explore Einstein's earlier interpretation of a Φ dependent *c* (which gives rise to the measured gravitational deflection of light, derived in that 1911 paper). (This was brought to our attention by J. Howard Drake.)

— *Hasn't the Puthoff analysis been disproven by Carlip?*

The Puthoff (1989b) paper contains two distinct parts. In the first there is an analysis which appears to show that the gravitational mass, m_g, is nothing other than the kinetic energy of *Zitterbewegung* motions. As with the ZPF model for inertia, mass appears to not be a fundamental thing unto itself, rather a manifestation of interactions. In this case the gravitational mass, m_g, appears to be (not "be equivalent to" but "be") the energy associated with the fluctuations imposed by the ZPF. (In the inertia model the inertial mass, m_i, appears to be the electromagnetic resistance of the ZPF on accelerating charge.) Thus from both the gravitational and inertial perspectives, mass is not a necessary concept. The second part of the Puthoff paper attempts to derive a specific inverse square force between particles based upon this model and this is what Carlip (1993) claims "contains a serious computational error." Puthoff (1993) responded to this, but it does appear that this part of the analysis is legitimately still in question.

– *Is the ZPF a kind of ether?*

Ether is a loaded term today because it is so widely described as an outmoded, discredited idea. The ZPF is not an ether of this sort. The 19th-century ether was an ill-defined "substance" providing a universal frame of rest and a medium for propagation of light waves. The ZPF *is* light waves and is therefore not akin to the mysterious substance called ether in the late-19th century. However an electromagnetic ether is a different matter. Dirac (1951) stated: "Thus with the new electrodynamics we are rather forced to have an ether." Moreover the ZPF is Lorentz invariant, a crucially important property. Being Lorentz invariant it cannot and does not act as a universal frame of rest for rectilinear motion (which we do not want in physics). However it provides a universal frame of rest vis-a-vis acceleration. Few physicists appreciate the fact that contrary to a widespread belief, acceleration in general is *not* relative in general relativistic mechanics; only gravitational acceleration is relative. This point has been made by Rohrlich (1969) and Rindler and Mishra (1994). In today's physics one does need a type of "absolute space": one that is absolute with respect to acceleration, but not with respect to rest or uniform motion. Mashhoon (1995, p. 188--189) states: "Absolute space-time must be invoked to explain inertial accelerations.....general relativity renders the acceleration of gravity *relative* while maintaining the *absolute* character of any nongravitational accleration" The Lorentz invariant ZPF provides this, and in providing this also gives rise to inertia thus providing a substantive form for Mach's principle. Further clarification courtesy of B. Mashhoon: Newton's equation of motion in special relativity can be written:

$$m\frac{d^2x^\mu}{d\tau^2} = F^\mu$$

where these are four-vectors and F^μ represents a non-gravitational force. In general relativity this becomes

$$m\left(\frac{d^2x^\mu}{d\tau^2} + \Gamma^\mu_{\nu\rho}\frac{dx^\nu}{d\tau}\frac{dx^\rho}{d\tau}\right) = F^\mu$$

The velocity $dx^\mu/d\tau$ is a time-like four-vector; the force F^μ is a space-like four-vector. The two are orthogonal to each other (see Moller 1972). If the space-like four-vector force $F^\mu \neq 0$ in any coordinate frame, it will be non-zero in all coordinate frames. The

$$\Gamma^\mu_{\nu\rho}$$

represent the gravitational force and indeed can be set equal to zero by a coordinate transformation. The non-gravitational force F^μ cannot be transformed away. Thus, turning the arguments around, the absolute nature of non-gravitational acceleration is demonstrated by the manifestation of a force that cannot be transformed away. It is in this sense that there is a need for a special reference frame that is not perceptible on account of uniform motion, but that is perceptible on account of non-gravitational acceleration. We propose that the (Lorentz invariant) ZPF plays this role.

— *What is the meaning of the bare mass, m_0?*

The bare mass and the damping constant are related via: $m_0 = 2e^2/3\Gamma c^3$. One can write the various expressions in terms of either m_0 or Γ. It may have been a mistake to even introduce the m_0 concept since everything can be written entirely in terms of Γ. The m_0 was introduced in our equation (12) (the HRP paper) to initiate a traditional mass-on-a-spring-type oscillation. The two m_0 terms establish an undamped oscillator with characteristic frequency ω_0. To this are then added the other three terms: radiation reaction, an acceleration term, and the ZPF-driving forces (electric only). These oscillations take place in the the *yz*-plane. We restrict oscillations to this plane in part to simplify the analysis, but more importantly to allow us to apply a forced acceleration $\vec{a}$ in the *x*-direction *perpendicular to the plane of oscillation*. This $\vec{a}$ does not drive the oscillations. It is simply imposed on the oscillating particle. We then look at the magnetic interactions between the oscillating particle and the ZPF, i.e. examine the

$$\vec{v}\times\vec{B}^{ZP}$$

force. This $\vec{v}$ is the oscillation-related velocity in the *yz*-plane; it is *not* due to the imposed in the *x*-plane. Our result is that the

$$\vec{v}\times\vec{B}$$

force turns out to be linearly proportional to and directed along the $\vec{a}$

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vector. This results from the acceleration-dependent asymmetry of the ZPF, not on any relation between $\vec{a}$ and $\vec{v}$

In other words, the

$$\vec{v}\times\vec{B}$$

force appears to provide a resistance to acceleration, which we identify with inertia; i.e.

$$\vec{v}\times\vec{B}$$

creates m_i. My present interpretation is that there is no mass (m_0) at the level of the oscillations. One should think of a damping constant, Γ, which exists for some as yet unknown reason. This can be formally written as if there were a mass (m_0) on a spring, but in retrospect this would appear to be a bad representation of reality.

—Aren't you just deriving an $\vec{F} = m\vec{a}$ ***relation from an*** $\vec{F} = m\vec{a}$ ***relation?***

The Abraham-Lorentz-Dirac equation (12) that we start from is indeed an

$$\vec{F} = m\vec{a}$$

equation, but we use it only to set up particle oscillations in a plane. The result we derive refers to acceleration perpendicular to this plane. We create an oscillator in a plane using the ALD equation; we then force this oscillator to accelerate at right angles to its oscillation; we investigate the resulting Lorentz force and discover that it is linearly proportional to the forced acceleration, i.e. we discover a resistance that we did not put there. This resistance has nothing to do with the

$$\vec{F} = m\vec{a}$$

relation we used to initiate an oscillation; our discovered resistance is perpendicular and arises of its own accord out of the acceleration-dependent asymmetry of the ZPF and the consequences of this on the $\vec{v}\times\vec{B}$ term and (both $\vec{v}$ and $\vec{B}$ being in the plane of oscillation).

— Is there some way to avoid using an $\vec{F} = m\vec{a}$ ***relation to force oscillations?***

One can initiate oscillations equating only the following

$$-\frac{2e^2}{3c^3}\frac{d^3\vec{r}}{dt^3} = e\vec{E}^{ZF}$$

which is tantamount to assuming that at this level the particle is indeed massless; the only resistance to the electromagnetic forcing is the radiation reaction. In other words, there is no inertia at this level. We have not yet carried through the kind of analysis done in the HRP paper beginning only with this.

—What is ω_0?

We assumed that ω_0 was an effective cutoff frequency for interactions between particles and the ZPF at the Planck frequency, ω_P. It may not be necessary for the ZPF itself to have such a cutoff, and indeed this may be undesireable since it would render the ZPF no longer absolutely Lorentz invariant at the highest frequencies. We argued that if particle size could be no smaller than the Planck length ($l_P \sim 1.6 \times 10^{-33}$ cm), this would cause a cutoff that is also effectively at the Planck frequency, so that we could still assume $\omega_0 = \omega_P$. It is now my view that ω_0 is likely to be a resonance frequency specific to a given particle, i.e. that $\Gamma = \Gamma_0\ \delta\omega_0$. The mathematical treatment would not be affected if this resonance were a true Dirac δ-function. In this way, for example, an electron could acquire a different mass than a muon, which has the same charge but is ~ 200 times heavier. The question then becomes one of determining the origin of $\Gamma(\omega_0)$, which may prove to be a fruitful new approach to fundamental particle masses. This is of course speculation.

— What is a parton?

The term was coined by Feynmann. We use it as a surrogate for any fundamental point-like charged particle, i.e. as a generic quark, as an electron, etc. An oscillating parton would be equivalent to a Planck oscillator. The partons must oscillate because they are subject to ZPF perturbations. (Also, if the partons did not oscillate, there would be no physics to do. Oscillation is the simplest possible periodic motion from which one can begin.) I further speculate that the difference between an ideal parton and real particles lies primarily in Γ (see above), and of course the charge. (Quarks come in charges of −1/3 and +2/3, electrons have −1.) This of course ignores other quantum numbers, such as quark color, etc.

— Could the same inertia and gravitation results be calculated using a quantum approach?

This has not yet been done. In principle this would have to be feasible or else it would contradict the hoped-for equivalence of SED and quantum physics.

— Where does Planck's constant hbar come from in SED if not from quantization? }

Boyer (1975, pp. 793--794) is very explicit on this point. The ZPF as a real electromagnetic field is completely defined by two properties. First, it must be Lorentz invariant: This uniquely defines the spectral shape as an ω^3 (frequency-cubed) spectrum. This leaves only the absolute value to be determined, i.e. having the energy distribution defined leaves only the energy density. The energy density is measureable in various ways, for example from the Casimir force. The constant that results is Planck's constant, h. In other words, in the SED perspective, h is an empirically determinable scale-factor for the strength of the ZPF. It is no coincidence that this same constant is the fundamental one in quantum physics: In the SED view, the perturbations caused by the ZPF *are* the source of quantum indeterminacy. That is why the Heisenberg uncertainly relation contains $\hbar$ because the ZPF fluctuations provide the irreducible stochastic noise that are conventionally interpreted as innate uncertainty.

— What is the relation between the ZPF and ordinary Blackbody radiation?

The radiation spectrum is:

$$\rho(\nu,T)d\nu = \frac{8\pi\nu^2}{c^3}d\nu\left(\frac{h\nu}{e^{\frac{h\nu}{kT}}-1} + \frac{h\nu}{2}\right)$$

The first term in the parentheses represents the blackbody radiation, the second represents the half a photon on average in every possible mode of propagation of an electromagnetic wave (direction, frequency, polarization state). The quantum interpretation is that one can neither rule out nor include for certain the existence of

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a single photon in any such given mode; hence on average space appear to be filled with half a quantum photon in each mode. The SED interpretation is that this is just the energy density of the ZPF that accompanies the Universe which can be interpreted as half a quantum photon but really just reflects the strength of the electromagnetic field.

— ***What is the relationship between SED and quantum physics, or the ZPF and the quantum vacuum?***

The quantum interpretation is that a certain virtual photon field is forced into existence by quantum uncertainty: this is called the quantum vacuum. The SED interpretation would be the exact opposite. A real electromagnetic field which has the same spectral properties as the quantum vacuum exists: this is the ZPF and its perturbations produce quantum phenomena. This can be pictured as analogous to Brownian motion in fluids. A universal Brownian noise forcing particles to undergo conservative diffusion as a physical basis for quantum mechanics was developed by Nelson (1966, 1967).

— ***Has the Schrödinger Equation been derived using the methods of Stochastic Electrodynamics?***

Nelson (1966) states: "We shall attempt to show in this paper that the radical departure from classical physics produced by the introduction of quantum mechanics forty years ago was unnecessary. An entirely classical derivation and interpretation of the Schrödinger equation will be given, following a line of thought which is a natural development of reasoning used in statistical mechanics and in the theory of Brownian motion." Examining the Heisenberg uncertainly principle Boyer (1975, pp. 802--803) showed that for the harmonic oscillator the fluctuations caused by the ZPF on the positions of particles is exactly in agreement with quantum theory. Rueda (1993a, 1993b) arrived at the Schrödinger equation in the context of a ZPF-induced Brownian-motion model.

— ***Doesn't the Planck Blackbody radiation formula depend upon quantization?***

Boyer has published derivations of the blackbody radiation formula without quantization but with the presence of a real ZPF (see Boyer 1984 and references therein). This is not surprising, since within the SED view the ZPF is the source of quantum fluctuations, and can therefore be made mathematically equivalent to quantization, even though physically the presence of a real electromagnetic field is very different than a law of nature calling for quantization.

— ***How can one account for nonlocality, the EPR paradox now verified by measurements of the Bell Inequality without quantum laws?***

This thorny issue has begun to be addressed by Garbaczweski and Vigier in various publications since 1990 which are referenced in the brief article by Gaeta (1993): *EPR and stochastic mechanics*. I do not yet see a satisfactory answer.

— ***What about the strong and the weak interactions?***

At this time the ZPF theory deals only with photons, not the W^+, W^- and Z^0 massive bosons mediating the weak interaction, nor the gluons of the strong interaction. This is certainly a deficiency. However the theory does unite gravitation and electromagnetism.

— ***What does the ZPF have to do with spontaneous emission?***

This is discussed in the article by Sir William McCrea (1986). Spontaneous emission can be rewritten so that (apart from a factor of 2) it is actually stimulated emission with the stimulating field being the ZPF.

$$A_{21} = \frac{2h\nu^3}{c^2} B_{21}$$

$$\rho_\nu = \frac{4\pi}{c} I_\nu$$

$$B_{21} I_\nu + A_{21} = B_{21}\left(I_\nu + 2I_\nu^{ZPF}\right)$$

It is now well known and has been frequently verified that spontaneous emission can be altered (both enhanced and reduced) by placing atoms in a cavity (e.g. Goy et al. 1983, Hulet et al. 1985). The factor of 2 discrepancy has to do with the intimate relationship between the ZPF and radiation reaction, each of which can be interpreted as contributing equally to the spontaneous emission (see Milonni 1982, 1988).

— ***What about the stability of the hydrogen atom?***

The origin of quantum mechanics traces to the mystery of why classically orbiting electrons do not radiate and spiral into the nucleus. In 1913 Bohr solved this problem by fiat, with his initial formulation of quantum laws forbiding emission of radiation except for discrete transitions of the orbital electrons. It turns out that for the ground-state of hydrogen SED offers a very intriguing alternative explanation. If one allows an electron to radiate classically, thereby losing energy, but also allows for the absorption of energy from the ZPF, one finds a detailed balance at precisely the first Bohr orbit. A preliminary version was developed by Boyer (1975); a more exact calculation was done by Puthoff (1987). The same simple approach cannot be applied to any excited states, nor have the orbital states of any other atom been successfully analyzed in this way.

— ***Can energy be extracted from the ZPF?***

There does not appear to be a thermodynamic impossibility in principle. Since the ZPF is not a thermal spectrum it is not the same as trying to tap an energy reservoir at zero-temperature. No credible technological method has of course yet been devised. See the article *Extracting Energy and Heat from the Vacuum* by Cole and Puthoff (1993).

— ***Issue: The concept of kinetic energy.***

Classically, the kinetic energy of an object is $E_{ke} = (1/2)mv^2$. Relativistically, the total energy (neglecting potential energy) of an object is $E=mc^2$. The relativistic mass of an object in motion is related to its rest mass via: $m=m_0/(1-v^2/c^2)^{1/2}$. The total energy of an object at rest (neglecting potential energy) is $E=m_0c^2$. The relativistic kinetic energy of an object in motion can thus be considered to be: $E_{ke}=mc^2-m_0c^2=(1/2)m_0 v^2$ + higher order terms.

Classically and relativistically, the kinetic energy is entirely relative to the observer. An observer sharing the motion of an object will attribute zero kinetic energy to that object, i.e. $E=m_0 c^2$ only. The only way to manifest kinetic energy is to decelerate an object in motion. Until this happens,

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there is nothing that can physically demonstrate the existence of the attributed kinetic energy. This must be the case because deceleration is the only way to actualize a difference between an object and an observer's coordinate systems.

A valid interpretation would thus appear to be that since inertial mass only manifests upon acceleration or deceleration, the concept of kinetic energy of a uniformly moving object is misleading. Acting upon an object to accelerate it does *not* put kinetic energy into the object; instead it is a process of doing work against the resistance of the ZPF. Deceleration is the inverse process, in which energy can be extracted from the ZPF (in place of the concept of extracting the kinetic energy from an object).

This concept appears to be testable. Since the ZPF consists entirely of electromagnetic radiation, any work done upon the ZPF would necessarily propagate as a flux of electromagnetic energy at *c*, which one could call an "inertia wave" in analogy to the "gravitational waves" of general relativity. Some part of the work done on the ZPF during the process of acceleration of an object should in principle be capable of absorption by a neighboring object. The existence of (possibly measureable) "inertia waves" would appear to be a necessary consequence of the theory.

— ***Issue: The concept of potential energy wrt change in inertial mass due to change in binding energy.***

The atomic mass unit (amu) is defined in terms of the ^{12}C isotope with 6 protons and 6 neutrons: $m_i(^{12}C\}) \equiv 12$ amu. This can conveniently be compared to ^4He with 2 protons and 2 neutrons for which: $m_i(^4He\})=4.002603$ amu, i.e. $3m_i(^4He)=12.007809$ amu. The difference is due to a drop in potential energy, Φ, of ^{12}C. How does a change in Φ translate into a change in m_i in the ZPF concept?

Toward an answer: In the Puthoff (1989b) analysis, gravitational mass, m_g originates in *Zitterbewegung* motions, i.e. let $< E_{ke} >$ be the kinetic energy of parton *Zitterbewegung*, then $m_g=<E_{ke}>/c^2$. A decrease in Φ can only come about from emission of energy. This emission of energy must come at the expense of the kinetic energy of the *Zitterbewegung*, i.e the Γ, ω_c (cf. Puthoff's eqn. 21) or more likely the $\Gamma(\omega_r)$, where ω_r is a resonance, must change (decrease) to alter this kinetic energy. But this would then also affect the $\Gamma(\omega)$ involved in the inertia-production, i.e. creation of m_i. In fact the same $\Gamma(\omega)$gives rise to both the kinetic energy of *Zitterbewegung* interpreted as m_g and the Lorentz force upon acceleration interpreted as m_i.

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Addendum to "Mechanisms of a Disobedient Science"

by David Moon
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Minnesotans have an expression they often use when observing someone who is fumbling with a supposedly simple or obvious situation: "It doesn't take a rocket scientist to...!" Hal Fox, Associate Editor of Infinite Energy and a retired missile engineer, couldn't agree more. What is obvious in cold fusion is the replicable excess heat and nuclear products. But simple? No, that would take away the fun.

This article is an addendum to the parent paper, "Mechanisms Of A Disobedient Science"[1]. The topics that will be addressed include proposals of reactions that might explain data from light water cells, and some metal transmutations in D_2O-Pd electrolysis experiments. Musings about microwaves and materials are made.

In "Mechanisms Of A Disobedient Science," a spectrum of reactions in cold fusion cells based on the extent of invasion of oscillating deuteron trains into areas or regions ("windows") inside the metal atoms was offered as a means of tying together the seeming disarray of data from six years of cold fusion research. This spectrum of reactions from windows I-VI is again given in figure 1:

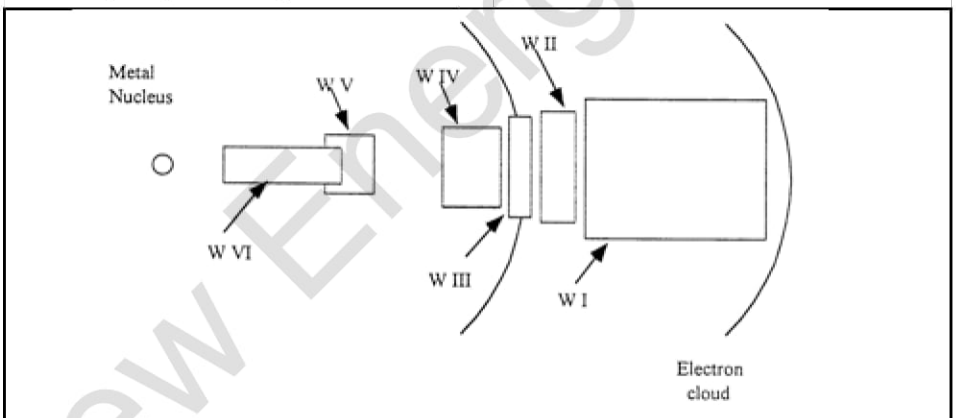

Figure 1 - Metal atom windows.

Generally, each window will make possible the following reactions when the deuteron train invades into that region of the metal atom's volume:

W I – d+d fusion producing He-4, lattice heat.

W II – formation of "unstable dineutrons" (UDN), which can react with metal nuclei to bring transmutations.

W III – conventional fusion of deuterium through partial electron screening

W IV – formation of tritium, which involves also a UDN formed by another deuteron trailing in Window II.

W V – formation of "stable dineutrons" (SDN), which can react with metal nuclei to produce transmutations, neutrons (3-7 MeV in Pd), and various fissions.

W VI – formation of energetic charged particles.

Which of these reactions occurs at any time within an active cell should depend on (1) the energy of the oscillating chain, (2) the compactness of the chain, and (3) the degree of resonance or coherency of the oscillations. Some cold fusion cells will see all or most of the windows become active, while other cells will favor one or two windows.

This article will attempt to account for some cold fusion data not addressed in "Mechanisms Of A Disobedient Science".

The Intermediate Neutrons

One of the great challenges to theorists working in the new physics of cold fusion has been to find reasonable mechanisms to overcome the Coulomb barrier between deuterons, protons and large metal nuclei. Dr. Jean-Paul Biberian (Orinda, CA and Marseilles, France) has a concept of a "transient neutron". Dr. Biberian writes, "...for a very short time, the electron might orbit the deuteron in a transient orbit, which is not a Bohr orbit, and therefore it can be much closer to the nucleus than otherwise expected from a stable atom[2]."

Dr. Biberian's concept of such a neutral particle probably is very close to the proposed "unstable dineutron", or UDN($^2n^*$). This intermediate dineutron was predicted to form in window II of a metal atom during invasion of the deuteron train[1]. During invasion, the lead deuteron that just reaches into window II – which in a palladium atom is the inner region of the electron cloud – will experience the right amount of Coulomb excitation and therefore can become resonant with an inner – orbital electron of the metal atom (perhaps the K or L shell). If the P.E. (deuteron) + E(orbital e^-) is in a resonant wave state for a long enough time interval – about 10^{-14} to 10^{-12} second, the time of action of the weak electronuclear force [3] – then the electron can add to the deuteron in a weak bond to become a UDN.

The UDN will migrate toward the metal nucleus to react with it, or will meet with a rebounding deuteron (from window IV) to make low energy tritium:

(a) $^{110}Pd + {}^2n^* \rightarrow {}^{111m}Pd$ (0.04 MeV) + (p + e^- + 3.33 MeV)

(b) d + $^2n^* \rightarrow$ t(recoil) + (p + e^- + 4.0 MeV)

In reaction (a), the Q-value is estimated by assigning an arbitrary value of E=0.030 MeV in the reaction, d + e^- +E $\rightarrow {}^2n^*$ + neutrino. This is the input energy, P.E. (deuteron) + E(e^-), added during the weak capture of an inner – orbital electron by the invading deuteron in window II, forming a UDN. This value is strictly an estimation, and would be expected to range in the 10's of KeV. This approximation is based on the energy of the neutron that is believed to be occasionally formed in reaction (a) when the 0.782 MeV required to convert the (p+e^-) combination to a neutron is reabsorbed during reaction:

(c) $^{110}Pd + {}^2n^* \rightarrow {}^{111m}Pd$ (0.04 MeV) + n (2.55 MeV)

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Researchers measuring neutron energies sometimes have reported an energy band of 2.5 MeV to 7.0 MeV from PdD electrodes. Perhaps reaction (c) accounts for the low end of this energy spectrum. The rate of these neutron emissions was previously predicted to be approximately 10^{-9} of the reactions of Pd with $^2n^*$ [1]. The same rate of 10^{-9} n/reaction was predicted for tritium production, reaction (b). This rate is based on the minimum neutron/tritium ratio typically reported in cold fusion experiments.

How close is the electron bonded to the deuteron in the UDN? Using the energy of 30 KeV in the UDN structure, the equation P.E. = Ze^2/r gives r = 48 fermis (4.8 x 10^{-12} cm) between electron and deuteron. At atomic and sub-atomic distances, another nucleus will see a neutral particle ($^2n^*$) with which to react. (That is, in the $^2n^*$ particle the captured electron is considered to add to and partly overlap with the deuteron, resulting in an effectively neutral particle.) Is the UDN equivalent to the mysterious "meshuganon" (from the Yiddish word meshuga meaning "crazy") that was suggested to possibly be the "yet undiscovered" neutral particle in cold fusion by Dr. Edward Teller in 1989? (see *Fire From Ice*, p.182)

Although it has been termed, in relative measure, an "unstable dineutron" in this theory, the UDN will have to be tight enough so as not to "rattle and fall apart" (unlike my 1978 Oldsmobile. Good V8 engine, though!) before it nears close enough (a few fermis or tens of fermis) to the metal nuclei to cause the various transmutations.

The counterpart to the UDN with heavy hydrogen is the UMN with light hydrogen. An "unstable mononeutron" (n*) is proposed to form inside a metal atom when the oscillating proton train invades into window II of the metal.

In nickel atoms, window II would be placed closer to the nucleus and probably overlaps the region of window III (figure 1). In fact, it may extend to the region of window IV simply because further invasion of the proton chains is needed with a smaller nuclear charge (Z = 28) in order to reach the resonant energy state for making a UMN. For example, a proton sitting just outside the first Bohr orbit of a nickel atom (~2x10^{-10}cm) will experience a Coulomb potential energy of about 18.7 KeV (assuming K-shell electron screening). An electron from the L-shell, should it be captured by the proton to form a UMN, will carry an additional ~ 16.4 KeV.

Therefore:

$$p + e^- + E \rightarrow n^* + \text{neutrino}$$

$$\begin{aligned} \text{where } E &= \text{P.E. (proton)} + E\,(e^-) \\ &= 18.7 \text{ KeV} + 16.4 \text{ KeV} \\ &= 0.035 \text{ MeV} \end{aligned}$$

If the resonant energy E happens to be larger than 0.03 MeV, window II will have to slide a little closer to the metal nucleus. A larger E - value might be expected based on the smaller size of the proton compared to the deuteron. Hypothetically, if E = 0.050 MeV, the captured electron abides at a distance of 28 fermis from the proton. Nevertheless, UMNs that form in light-hydrogen experiments are considered real neutral particles, as are UDNs that form in heavy - hydrogen experiments. Both kinds of intermediate neutrons can account for major data in their respective cold fusion experiments. They are especially big contributors in H_2- and H_2O - experiments where light does not mean fewer calories!

Some Like It Light

It is already written into the history of science: The 1989 press conference by Drs. Fleischmann and Pons claiming fusion of heavy hydrogen at room temperature inside palladium electrodes sent a lightning bolt - a coup de foudre - through the world of nuclear physics. If that wasn't enough shock, the announcement two years later by Dr. Randell Mills of excess heat extracted from light water cells using nickel cathodes sparked more than light interest - and disbelief. Can lightning strike twice?

Replication and verification of the cold fusion effect in H_2- and H_2O-systems has been performed in many laboratories worldwide since 1991. Review of these is not necessary, but two analytical works will be cited to see if they can fit into the "spectrum of reactions" in this theory.

Seminal work of cold fusion by sparking in hydrogen gas has been done by Dr. Jacques Dufour, Shell Research S.A. (France). In a 1993 article[3], Dr. Dufour writes: "A concept different from electrolysis is used: the action of a high transient electrical field on hydrogen isotopes concentrated in the surface layer (few micrometers) of a metal in contact with a gaseous mixture containing hydrogen isotopes. The transient electrical field is created by sparking through the gas between two dissymmetrical electrodes, in which the surface layer of hydrogen isotopes is built... Precise and repeated energy balances show that excess energy is generated in the system, in a fully reproducible way. The amount measured on a steady-state basis (several days) excludes chemical or physical explanations. This excess energy production is observed with both hydrogen and deuterium and with various metals, even those forming unstable hydrides (iron, nickel), indicating a surface reaction.... Indications of the emission of b- particles have been observed... practically no tritium and no neutrons were detected."

The essential reactions Dr. Dufour offered are given below, with some alterations adapting them to the model of deuteron (or proton) interactions with metal atoms during collective oscillations of linear chains against metal - atom barriers. These reactions are hypothesized to occur inside window I (toward metal nucleus).

For experiments involving light hydrogen:

$$(1)\ p + p + e^- \xrightarrow[?]{e^-\ \text{cloud}} d + \text{neutrino}, \quad (Q = 1.442\ \text{MeV})$$

Here the e- in the three-body fusion, orbiting within an inner electron shell of Ni (or other metal), draws (screens) the excited proton pair (which is part of the invading train of protons) into the "virtual neutron state" (p+n+neutrino) described by Dr. Dufour [3]. This state is 0.782 MeV higher than the (p + p + e^-) state, so that the usual Q-value of 2.224 MeV released during the fusion of p + n → d has been reduced by 0.782 MeV. That quantum portion is reabsorbed during the (p + p + e^- → d) reaction, giving a net 1.442 MeV released. However, it is proposed this energy release is taken up mostly by the dense inner electron cloud of the metal atom, which is connected to lattice phonon vibrations. A minimum amount of energy is carried away by the neutrino.

As deuterons form in reaction (1), they may undergo subsequent reactions during oscillation of the hydrogen chain, inside the metal atom's electron cloud:

$$(2)\ p + d \xrightarrow{+e^-\ (e^-\ \text{cloud})} t + \text{neutrino}, Q = 5.47\ \text{MeV (mostly lattice)}$$
$$p + d \xrightarrow{e^-\ \text{cloud}} {}^3He + 5.49\ \text{MeV (lattice)}$$

$$(3)\ p + t \xrightarrow{+e^-\ (e^-\ \text{cloud})} {}^4H + \text{neutrino}, Q = 19.76\ \text{MeV (mostly lattice)}$$
$$p + t \xrightarrow{e^-\ \text{cloud}} {}^4He + 19.81\ \text{MeV (lattice)}$$

followed by:

$$(4)\ {}^4H \rightarrow {}^4He + \beta^- + \text{neutrino}, Q \approx 50\ \text{KeV}$$

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The only significant nuclear activity recorded by Dr. Dufour in his H2(D2)-sparking experiments was low-energy bremsstrahlung events. Careful arrangement of sensitive x-ray films suggested that emission of beta particles were occurring in reaction (4) with an energy of about 50 KeV and a half-life of 20 minutes.

It is important to note that reactions (1)-(4) above, and reaction (5) below, will produce soft x-rays mentioned plus ultraviolet radiation (not detectable in the Dufour set-up) which are a result of electrons changing energy levels in the metal atoms from e- capture during fusion reactions.

In the case of sparking in deuterium, the cold fusion reactions proposed are (modified from Dufour)

$$(5)\ d + d + e^- \xrightarrow{e^- \text{ cloud}} {}^4H + \text{neutrino}, \quad (Q = 23.8\,\text{MeV})$$

(mostly lattice energy)

followed by beta decay in reaction(4).

If a second electron is simultaneously taken up during fusion in reaction (5), quad-neutrons are produced:

$$(6)\ d + d + 2e^- \xrightarrow{e^- \text{ cloud}} {}^4n + \text{neutrino}, \quad (Q = 23.8\,\text{MeV})$$

(mostly lattice energy)

Since an additional electron has been absorbed during d + d fusion to form ^4n, it seems reasonable to assume that this requires greater excitation, and thus will need further invasion of deuteron trains into the volume of metal atoms. Therefore, reaction (6) is predicted to occur in window II, but not likely in window I.

The Dufour paper revealed that "no gamma photons were detected" in their deuterium-sparking experiments[3]. Consequently, quad-neutrons were not manufactured in measurable numbers during deuterium sparking. When produced, they would be expected to cause gamma emissions after being captured by the host metal's nuclei. As an example, stainless steel electrodes could predict reactions such as:

$$^{56}_{26}Fe + {}^4n \rightarrow \left[^{60}_{26}Fe\right] \rightarrow {}^{56}_{24}Cr + {}^4_2He$$

$$\xrightarrow[(5.9\ m)]{-\beta-\gamma} {}^{56}_{25}Mn \xrightarrow[(2.5\ h)]{-\beta-\gamma} {}^{56}_{26}Fe$$

This brings the discussion to the second important analytical work with light-water cold fusion, at California State Polytechnic University in Pomona. (There are certainly other important research efforts in light water, such as the work by R. Notoya in Japan and M. Srinivasan in India.) Drs. Robert Bush and Robert Eagleton have used specially prepared nickel mesh cathodes with alkali-metal electrolytes in closed cells. Generous amounts of excess heat are consistently produced at an average of 1,000 percent excess power - a figure often quoted for H_2O-Ni experiments - for extended periods of time [4] . Dr. Bush's "Cold Alkali Fusion" hypothesis predicts, for example, the manufacture of calcium when potassium carbonate is used as the electrolyte. Dr. Bush's theory will be adopted to the reaction mechanisms presented here by employing the UMNs described earlier:

$$(7)\ {}^{39}_{19}K + n^* \rightarrow {}^{40}_{20}Ca + e^- + \text{neutrino}, \quad (Q = 8.35\,\text{MeV})$$

(Q is estimated using mass of n* equal to 0.035 MeV greater than the mass of p + e^- , giving purely an approximation.)

The UMNs are predicted to form in window II and III, and possibly also in window IV:

$$(8)\ p + e^- \xrightarrow{e^- \text{ cloud}} n^* + \text{neutrino}$$

Also, deuterons formed in reaction (1) above will occasionally be converted to UDNs which then can bring about transmutations; for example:

$$^{39}_{19}K + {}^2n^* \rightarrow {}^{40}_{20}Ca + e^- + n, \text{ or}$$
$$^{39}_{19}K + {}^2n^* \rightarrow {}^{40}_{19}K + e^- + p, \text{ or}$$
$$^{39}_{19}K + {}^2n^* \rightarrow {}^{41}_{20}Ca + e^- + \text{neutrino}$$

Radiations in the form of UV and soft x-rays will be associated with reactions (7) and (8). In addition, characteristic x-ray lines from potassium and probably nickel would be emitted due to the action of energetic electrons generated in reaction (7). For example, the $K_{\alpha 1}$ - lines of potassium (3.31 KeV) and nickel (7.47 KeV) might be identified. However, x-ray detectors (or film) placed externally to the reactor probably will not receive these emissions, but x-ray film positioned inside the cold fusion cell, whether of light or heavy hydrogen, will be fogged by the soft x-ray emissions from reactions (1) - (8). Generally, only hard x-ray bremsstrahlung generated by fast electrons formed in reaction (7) would be detected outside a closed cell.

If reaction (7) were to explain essentially all of the excess heat from a K_2CO_3/H_2O/Ni cell in any particular experiment, then x-ray intensity would correlate with the excess heat, as would the calcium produced. The Bush/Eagleton experiments have given such correlations[4]. Nevertheless, the theory presented in this article must allow for reactions(1)-(3) to make a contribution to the excess heat, as well. In fact, in the absence of hard x-rays, these reactions become the sole account of excess heat.

What about H_2 gas - Ni systems in which alkali - metal salts are not present? This method can produce high rates of continuous excess power, too.

In reaction chambers containing gaseous light hydrogen with nickel electrodes, the model of proton - metal interactions from oscillations of long chains of hydrogen nuclei also is applied. Therefore, nickel can participate in all nickel - hydrogen experiments.

A sample reaction is:

$$^{62}_{28}Ni + n^* \rightarrow {}^{63}_{29}Cu + e^- + \text{neutrino}, \quad Q = 6.16\,\text{MeV}$$

The appearance of copper and perhaps zinc in NiH systems is expected to occur in this theory, but only when UMNs form.

There might be another "nuclear" source of excess heating, which would produce nothing more than soft x-rays, at most:

$$^{58}Ni + n^* \xrightarrow{e^-} {}^{59}Ni + p\ (\text{about 200 KeV or more})$$

Up to perhaps 200 KeV of kinetic energy is extracted when the UMN has its attached electron stripped, at a distance of about 200 fermis or less from the Ni-58 nucleus, followed by Coulomb acceleration of the exposed proton away from the metal nucleus - - which likely has no tendency to add the proton.

Transmutations In Texas

Often in science, experiment is the chicken and theory is the egg (or is it the other way around?). Experimental data can give birth to interesting and sometimes necessary ideas. But if experimental results are kept cooped up for a period of time, the theoretical idea that possibly could explain them might not hatch.

Such was the case in Pons-Fleischmann-type electrolysis experiments conducted in 1992 at Texas

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A&M University, in which Dr. Kevin Wolf found undeniable gamma-ray evidence for transmutation of palladium into several new metals six weeks after ending the electrolysis [5]. This revelation was hidden for three years – "politics," I understand – but was finally cracked open by Dr. Tom Passell, cold fusion program director at the Electric Power Research Institute, in a talk at ICCF5 in April, 1995.

That which finally developed out of Dr. Wolf's data, as far as this theoretical model is concerned, is the idea of the possible production of quad-neutrons (along with other neutral particles: ^2n, $^2n^*$, n^*), which could explain particular element shifts in Dr. Wolf's palladium cathodes. I want to emphasize, however, that this CF model is not the first to propose the formation of quad-neutrons. Dr. Takaaki Matsumoto, cold fusion researcher in Sapporo, Japan, is among probably several scientists who have postulated di- and quad-neutron activity in cold fusion cells [6].

In the Texas "hot" palladium cathodes, the identified new isotopes included:

Silver 110m	Rhodium 102
Silver 106m	Rhodium 101m
Silver 106	Rhodium 101
Silver 105	Rhodium 99
Rhodium 102m	Ruthenium 103

How might these transmutations take place? Egged on by the reality of Dr. Wolf's data, Dr. Eugene Mallove wrote in his *Infinite Energy* article [5]: "For example, it would not be too far-fetched to imagine that some excited state of Pd-110 might emit a beta particle (changing a neutron to a proton) resulting in Ag-110. One might imagine that Ag-106 might be created via a similar mechanism... But how would rhodium-99 be obtained? One way, as Passell pointed out, would be to assume that a proton is absorbed by Pd-102, quickly followed by alpha emission. This would temporarily create Ag-103, and then Rh-99 upon ejection of the alpha particle, since an alpha particle consists of two neutrons and two protons. Still, many scientists find it difficult to accept that a proton could get close enough to interact with a larger nucleus, since both are positively charged and thus strongly repel each other via Coulomb repulsion."

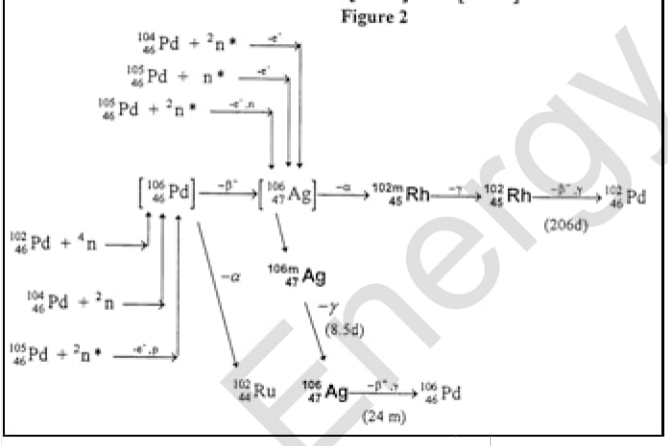
Reaction diagrams showing reactant and product pathways can be drawn for each of the palladium isotopes. Figures 2-5 below illustrate four such sets of branches. Each branch will not be equally probable, but taken together they might account for the isotopes registered by Dr. Wolf. (Symbols in bold represent isotopes identified at Texas A&M, six weeks after terminating the heavy water electrolysis.)

Picket Fences

It's Saturday night (July 29,1995) – the Laura Lee Show – live! I'm listening on KSTP-AM from St. Paul, Minnesota. Hal Fox is the special guest. A caller is on the line and he is interested in cold fusion materials. In his own home-spun way, Hal answers, "the materials that work best are like picket fences – single crystals." I wish I had come upon this radio program at the beginning (I caught only the last part). I would have put on my new "Cold Fusion Lives" T-shirt, poured a bowl of microwave popcorn, and kicked back to enjoy one of the most widely knowledgeable gentlemen in the cold fusion field – a real Catalyst for all who are active in what Dr. Edmund Storms calls "one of the greatest discoveries of the last several

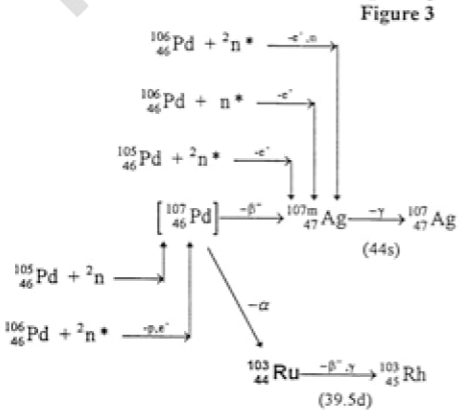
Branches of $[^{106}_{46}Pd]$ and $[^{106}_{47}Ag]$

Figure 2



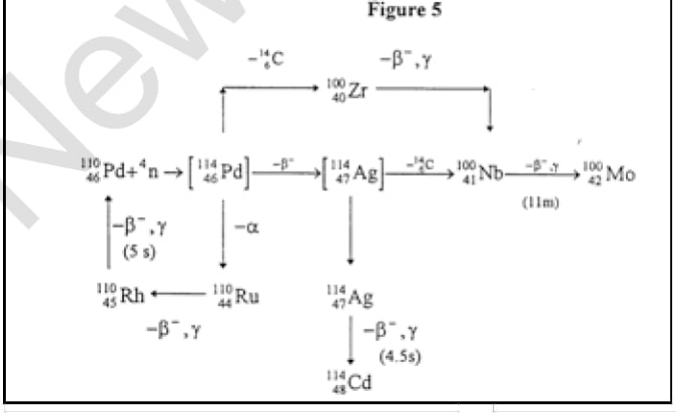
Branches of $[^{107}_{46}Pd]$ and $[^{107}_{47}Ag]$

Figure 3



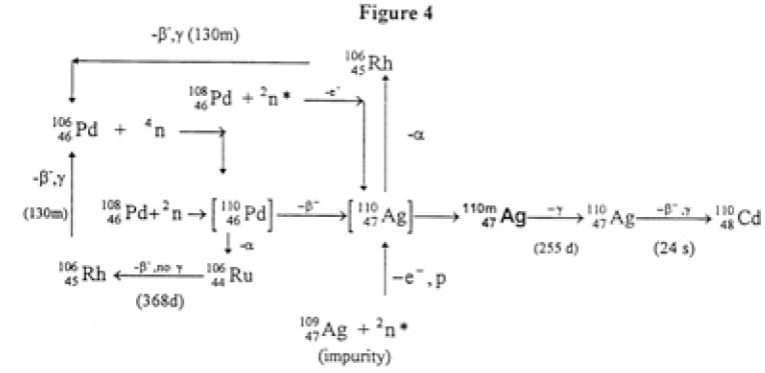
Branches of $[^{114}_{46}Pd]$ and $[^{114}_{47}Ag]$

Figure 5



Branches of $[^{110}_{46}Pd]$ and $[^{110}_{47}Ag]$

Figure 4



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centuries."

This cold fusion theory has taken the approach that to have an active cold fusion electrode, it helps to "have all your ducks in a row" (scratch the chicken analogy), that deuterons or protons packed into an active volume (active surface) of the cathode will assemble themselves into highly ordered layers which are "plasmoidal" and mobile, making possible collective, coherent oscillations of chains of the hydrogen nuclei against metal-atom barriers.

With this necessary arrangement of mobile deuterons, it is not unusual that larger single-grain crystals work best in cold fusion cells. The picket fence idea of crystal structure seems plausible to help organize deuterons or protons into long chains. (Surface catalysis is also a factor, and may help explain why nickel, titanium, tin, gold and other metals work so well with light hydrogen.)

Jean-Paul Biberian summarized his concept of "strings of deuterons" by stating: "The quality of the host lattice is important. Single crystal grains must be large enough to accommodate long strings, probably several microns in length... It is harder to make a linear string in a three dimensional world than in a two or even one dimensional one. Perhaps laminar materials are more suited for that, like high-temperature superconductors, or graphite-type compounds. Even better could be the use of zeolites, some of which are excellent proton conductors, that have one-dimensional structures." [2]

Is the layered, linear (parallel) structure of graphite, for example, a helpful agent to line up long trains of protons to do "microwave sonoluminescence"? Warren Cooley and Chuck Bennett recently reported "the discovery of microwave sonoluminescence in a matrix of activated carbon. Experiments with common graphite treated with liquid water then subjected to microwave radiation [using an ordinary kitchen microwave oven] reveal small bursts of light very similar to the sonoluminescence effect in cavitation bubbles."[7]

Mr. Bennett and Mr. Cooley write further comments that I believe should be given consideration: "The presence of free individual carbon atoms seem to add to the effect. When dry graphite is preheated in the microwave oven, the carbon structure is annealed into a weak crystalline structure that is nonhygroscopic thereby short circuiting the effect. Activated carbon with loose individual carbon atoms retains water vapor on the surface and in the micropores of the carbon structure. Then microwave radiation disassociates hydrogen from the water. Then some, as yet unknown, transmutation or fusion takes place."

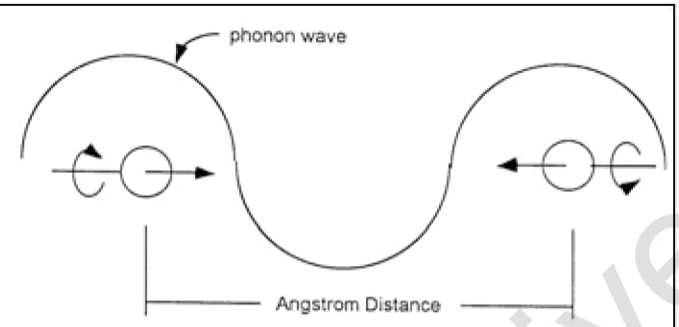

Figure 6
Linear (Phonon - mediated) Cooper Electron - Pairs

You mean to tell me that when I ask the waiter or waitress in the restaurant to reheat my lukewarm dinner I can say "nuke it!"? Well, maybe not quite. But there might be something to the notion that water molecules absorbing resonant microwave energy - dislodging protons at a catalytic surface to undergo collective oscillations - can focus the available energy into a wave pulse along the proton chain, resulting in sufficient excitation at the "point of attack" to cause effects like sonoluminescence or cold fusion reactions.

The collective energy is key. The proton or deuteron train (chain, string) is treated as a macroscopic quantum element. For example, a hypothetical chain of 10^5 protons has a mass of $10^5 \times m_p$. Permit-ting the use of classical mechanics applied to the oscillating chain, the formula for the frequency of a periodic (harmonic) oscillating body is inversely proportional to the square root of its mass: $f \propto 1/(m)^{0.5}$. Thus, the frequency of vibration of 10^5 protons or deuterons is $1/(10^5)^{0.5}$, or 316 times slower than a single proton or deuteron. As an example, if individual protons in the surface layers of the metal lattice vibrate at, say, 10^{12} Hz, then an oscillating chain of 10^5 protons would be in the collective frequency of about 1000×10^9 Hz / $316 \approx 3.16 \times 10^9$ Hz. Choosing an arbitrary value of 2.5 eV of kinetic energy per deuteron or proton, which is 100 x thermal energy, the total collective energy of the chain is 2.5 eV x 10^5 = 0.25 MeV - enough energy to push the chain almost into window V of a palladium atom.

Window V is the region inside the volume of the metal atom where stable dineutrons (SDNs) form. Instead, if the invading deuteron or proton chain were to immediately rebound from the large Coulomb barrier of the metal nucleus, any of the various fusion reactions previously described would be possible with the help of electron screening inside the metal atom's electron cloud. It is the amplitude of the oscillating chain, determined by the total energy, as well as the compactness of the chain that determines (1) the extent of invasion into the barrier metal atom, and (2) which of the reactions (windows I - VI) will occur. Selecting the preferred heat-producing reactions (in windows I and II) is a matter of finding the correct energies and frequencies for the oscillating chains. Of course, the first step is to build the chains. That is why high surface and near-surface loading is required.

Chain Links?

The view has been expressed by several scientists that high-temperature superconductivity (HTSC) and cold fusion have one thing in common: they are both collective phenomena. In the case of HTSC, the Bardeen-Cooper-Schrieffer(BCS) theory talks of Cooper-pairs of electrons. Perhaps even Cooper chains are possible. Dr. Millennium Twain of Menlo Park, CA, who is working on a book, The Undiscovered Physics, wrote: "...[Cooper-pair] electrons are not congruent space-wise, but are distantly paired with opposite spins and magnetic moments. That is why it seems to me to be related to atomic electron s-shell pairs. However, I believe there is said to be a big difference. Whereas an s-shell pair of opposite-spin atomic electrons occupy the same or adjacent space - - Cooper-pair electrons are said to couple at great (relatively) distance from each other. In other words, at some greater distance (molecular?) two electrons develop some harmonic (phonon or other) harmony or beat which is related either to their periodic ('orbital'?) motion about a molecule or

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ion or group, and/or to their helical propagation motion through the lattice. They say the pairs are generally 's-wave' (phonon mediated), but sometimes 'd-wave' or 'p-wave' (non-phonon mediated),"[8].

Figure 6 is an attempt to represent phonon-mediated Cooper-electron pairs (interpretation from Twain):

Dr. Twain is also considering additional pictures of Cooper pairs, and admits (as does this author) only to "not too rigorous speculations" at this time.

In the case of at least neighboring s-electrons in the lattice of a superconductor, it is reasonable to believe that the material is able to build chains of Cooper pairs when the temperature is lowered to the critical temperature, because at Tc coherent domains in the lattice have enlarged and "grown together" so that phonon vibrations are coherent on a larger scale and encompass a much larger domain. The s-electron band becomes a macro quantum element - a single entity.

The natural question that follows, in this present cold-fusion model of deuteron (or proton) alignment in H-loaded electrodes, is whether a Cooper link is involved in building deuteron chains, and how could that knowledge be utilized? Dr. Twain comments: "...statements about the axial filament alignment of the electrons or protons (and perhaps deuterons) is precisely in agreement with what I have inferred so far from my understanding of plasma physics and my metric relativity theory. The only disagreement I have with your suggestions is your statement that axial (propagation) alignment of protons, etc. must take place only at a surface. I believe the axial coupling of particles into filaments is much more general than the cold fusion reaction."[8]

One interesting difference between HTSC and CF is the response to an applied magnetic field. A magnetic field eventually breaks down HTSC, but has been shown to enhance cold fusion. In the case of HTSC, perhaps it can be assumed that an outside magnetic field orients the Cooper-pair electrons N-S - - - N-S, so that their spins suddenly violate the requirement of zero net magnetic moment, breaking the bound pairs.

For cold fusion cells, it would seem that an applied magnetic field also would destroy any existing Cooper-pairs of protons or deuterons for the same reason. This fate does not encourage a theory of Cooper chains of protons in cold fusion. Instead, the simple explanation is to assume that the magnetic field helps align deuterons or protons in the oscillating chain (to make a straighter chain), and Cooper pairs are not required (though they still might exist), therefore zero net spin is not the issue in the chains. The hydrogen nuclei tend to follow the magnetic lines. If this elementary interpretation is true, could this explain the increased efficiency of Ni-H_2 systems, in which the ferromagnetic property helps form linear arrangements of protons on or near the nickel surface?

Indeed, if protons or deuterons lined up in a chain can become unidirectional in their spins, the oscillating chain has a net magnetic moment of its own when immersed inside a magnetic field. Thus, a hydrogen-loaded electrode should exhibit a stronger magnetic field, induced by the applied field, than a hydrogen-free electrode. Of course, this assumes chains have been allowed to build. It would be very interesting if the effect could be measured experimentally.

Proof Is In The Pudding

In *IE* issue #3, ideas for test electrodes were suggested[1]. They involved application of microwave energy. Another idea is to use crystal structures that promote the building of deuteron or proton chains, perhaps in conjunction with properly oriented magnetic fields. Dr. Biberian looked at grain size - several microns (perhaps ~10mm) in length. Such crystals could alternate with thin strips of "barrier" metals - metals with large electron clouds, e.g. Au, W - to promote the fusion reactions in windows I and II.

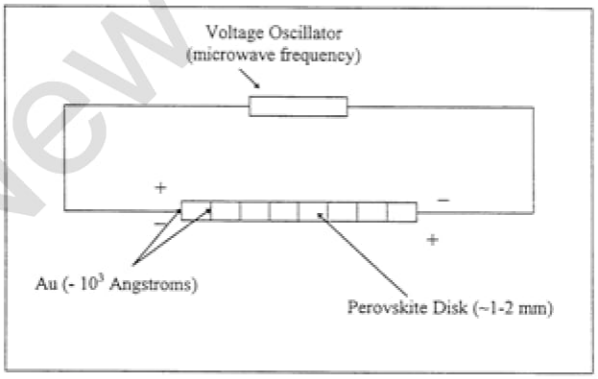

Figure 7

Is the geometry of the crystal important? Useful cathodes like Pd, Ni and Au have a face-centered cubic (fcc) structure. But Ti is hexagonal-close packed (hcp). Other fcc-metals include Ce, Cu, Rh, Ag, Pb, Ir and Pt; however, platinum does not seem to perform well as a cathode, though it has undergone transmutations on palladium, such as Pt Æ Au. Some cubic crystals include Ge, Co and Si. Chuck Bennett and Warren Cooley showed that activated carbon soaked with water can show the sonoluminescence effect when targeted with microwaves. Might some form of inexpensive graphite be promising in a commercial cold fusion device?

Tin metal has been effective in light water experiments. Tin comes in two structures: cubic (gray) and tetragonal (silver-white) and probably has special surface-catalytic properties. No doubt, there are enough experts in materials, surface catalysis and other engineering skills to assure the development of the most promising cold fusion devices. These devices, I believe, will be guided by the goal of trying to form long chains of hydrogen nuclei in the surface layers of pure, large-grain crystals having a large surface area. The chains will oscillate collectively and coherently in and out of large-metal interfaces or boundaries. It might be that these oscillations will be throttled by a microwave frequency of varying intensity.

Proton-conducting perovskites seem to be a promising alternative to palladium or titanium electrodes, as many experiments have shown. I understand the overall deuterium loading is small but may be locally dense. The hypersensitive performance of experiments is due, in part, to the random appearance and disappearance of these locally dense regions, where deuteron concentration is above a threshold level for reaction. Some researchers use pulsed voltages to drive the protons or deuterons through the ceramic oxide, presumably to create what Dr. Eichi Yamaguchi calls "accumulation layers." Of course, he achieved concentrated layers of deuterons employing palladium foils coated with gold on one side and manganese oxide on the other.

Therefore, a proton conductor might be constructed using alternating

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layers of gold and ceramic oxide for the purpose of building accumulation layers of deuterons, as in figure 7. After deuterium has been introduced into the perovskite disks, the approach would be to create coherent deuteron oscillations back and forth against the gold barriers, rather than driving deuterons through the material in one direction only. Perhaps this can be accomplished with the application of an oscillating voltage at the resonant microwave frequency of the trains (or chains) of deuterons. Then reaction mechanisms described previously can occur as long as the accumulation layers at the gold - perovskite interfaces are maintained.

As reactions continue, more deuterium should feed into at least the surface layers of the perovskite disks in the D2 - gas-filled chamber, which is operating at an elevated temperature (- 400°C). A near-surface active volume might be all that is needed (P. Glück, "Surface dynamics"). Dr. Mizuno's first sample, which melted, was judged by him to have done so during the first minutes after starting his experiment, implying a near - surface event [9].

Tiny Bubbles

Thus far in this theoretical model, collective oscillations of long chains of deuterons or protons against metal - atom barriers have been used to explain essentially all nuclear phenomena and excess heating from cold fusion experiments of varying types. This includes the cavitation methods of Roger Stringham and Russ George (ultrasound) and James Griggs (Hydrosonic Pump™). In this theory, cavitation action serves as a means of loading surface layers of metal structures with plasmoidal hydrogen nuclei. Post - run analysis of the metal surfaces reveals the degradation by the cavitation effects.

The Yusmar thermogenerator, using a vortex cavitation mechanism, does not show the same wear and tear in its pump, motor or vortex tube. Developed by Dr. Yuri S. Potapov (Kishinev, Moldova), this commercially distributed unit performs (Ed note: performs *reportedly!*) at 3-10 times the amount of heat out as energy in. After his interview with Dr. Potapov, Christopher Tinsley reported, "A vortex is established in the liquid in the tube. The velocity gradient within the liquid is so great that cavitation occurs - not between the liquid and the tube wall, but between adjacent layers of liquid. This is of course reminiscent of the Griggs Hydrosonic machine, but in that device the cavitation is induced by shear between metal and liquid, not between layers of liquid" [10].

The most curious question becomes, "Is it nuclear?" Some advanced theories involving mass - energy conversions have been given, most notably by Prof. Lev Sapogin (Moscow)[11], and by Dr. Hal Puthoff (Austin, Texas) whose theory of producing excess energy involves extraction from the quantum fluctuations of space, that is, the electromagnetic background (Zero Point Energy)[12]. This article is not prepared to incorporate these more esoteric theories into the current model at this time. Instead, collective oscillations of chains (or strings) of plasmoidal hydrogen nuclei (in the cavitation bubbles) are postulated to come against the "compressed bubble wall", which serves the same function as metal - atom boundaries in solid lattices.

In a letter to *Infinite Energy* [13], Dr. Talbot Chubb of Arlington, Virginia writes, "Getting heat from ordinary water seems a bit improbable, except when you think of the conditions existing during cavitation: 50 atm of pressure for 10^{-9} s, water - compression - heating raising the water temperature to 120°C, with some of the water crystallizing to ice VII. Lots of shock wave excitation to put all kinds of ions into excited states, which with a solid, and maybe even with a liquid could mean band state occupations."

Dr. Chubb's "excited band states" could very well be representative of the chains of oscillating hydrogen nuclei which is the foundation of this entire theoretical model. In the case of fusion reactions (in window I), the screening mechanisms to bring deuterons or protons together to fuse is the electron cloud of a lattice metal atom at a barrier such as a grain boundary.

In the Potapov thermogenerator device, where cavitation occurs between liquid layers and not at the metal surfaces, the highly compressed wall in the collapsing bubble will take the place of grain boundaries. Chains or strings of plasma - like hydrogen nuclei, which exist in a high energy band within the collapsed bubble, will act collectively as they transiently come against the condensed state of the bubble wall. Then, the invading protons can interact much like previous reactions given in this theory,

$$\text{e.g. } p + p + e^- \xrightarrow{e^- \text{ cloud}} d + \text{neutrino} + 1.442\,\text{MeV}$$

(mostly lattice energy)

If pure water constitutes the liquid in the Potapov vortex cavitation chamber, it will be the oxygen atoms that will be invaded by the trains of energetic protons, which then provide the electron clouds for screening. However, because of less electron density in oxygen, fusions in window I are slow. Other reactions account for most of the heat. For example, proton chains reaching into window II or III of an oxygen atom (at the cavity wall) perhaps are converted to UMNs at a certain rate

$$p + e^- \xrightarrow{\text{oxygen } e^- \text{ cloud}} n^* + \text{neutrino}$$

As in the earlier discussion of these reactions, soft x-rays and UV radiation are a required byproduct. Chris Tinsley reported on the Potapov machine: "Thorough searches have been done for x-rays, gammas and neutrons, with nothing found. Admittedly, some lower energy particles might fail to penetrate the thin wall of the Yusmar machine..."[10].

The UMNs (n*) formed have free access to the oxygen nucleus. In a related article discussing light water and cavitation methods [14], Drs. Talbot and Scott Chubb offered the following reaction:

$$^{1}H + {}^{18}O \rightarrow {}^{19}F + 8.0\,\text{MeV}$$

They gave the "abundance ratio $^{18}O/^{16}O = 2\times10^{-3}$ in H_2O, as compared with $D/H = 10^{-4}$, which favors the ^{18}O reaction [over the impurity D+D fusion]..."

In the same publication [14], a proposed reaction by Alan DeAngelis (Pennington, NJ) is reviewed:

$$^{2}H + {}^{17}O \rightarrow {}^{4}He + {}^{15}N \quad Q=9.8\,\text{MeV}$$

Both of these oxygen fusions can easily occur in this model using the UMNs or UDNs that form inside the oxygen atom's volume:

$$^{18}O + n^* \rightarrow {}^{19}F + e^- \quad (\approx 8.0\,\text{MeV})$$

$$^{17}O + {}^{2}n^* \rightarrow {}^{4}He + {}^{15}N + e^- + 9.8\,\text{MeV}$$

Interestingly, it has been recently reported that researchers "produced some fluorine from water vapor using

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electric and magnetic fields" [15]. A desirable but perhaps improbable measurement would be detection of fluorine in mechanical cavitation water supplies, such as the Potapov device -- improbable because of the large bulk material involved.

MeV-level electrons produced in the above oxygen fusions would generate bremsstrahlung emissions containing probably both hard x-ray (10's, perhaps 100's KeV) and soft x-ray components. Any very hard x-rays, if generated, would pass through walls of the cavitation chamber. However, not knowing the specifics of the cavitation apparatus (i.e. wall thickness) it is impossible to conclude what radiations are detectable externally. As reported by Chris Tinsley, tests on the Potapov thermogenerator indicate no external radiation [10].

Oxygen-16 might contribute considerable excess heat by turning back the approaching UMN:

This is another "hidden" source of excess energy, generating only soft radiation.

$$^{16}O + n^{*} \xrightarrow{e^{-}} {}^{16}O + p \text{ (about 100KeV)}$$

Violent mixing within the large mechanical cavitation devices increases the nitrogen content of the water through aeration. Any UDNs that form during oscillations of hydrogen nuclei in the cavitation bubbles can react with the dissolved nitrogen:

$$^{14}N + {}^{2}n^{*} \rightarrow {}^{16}O + e^{-}, \text{ (Q= 20.7 MeV)}$$

It is curious that the cavitation methods of Griggs and Potapov give excess heat with H_2O, but the ultrasound cavitation of R. Stringham and R. George does not produce measurable excess heat with Pd in H_2O. Early in CF research, Pd - H_2O electrolysis became routinely used as a control cell. But then E. Yamaguchi found excess heat in his famous "outgassing" experiments using either H_2 or D_2 gas with palladium. And other Pd - H experiments have also given heat or nuclear effects, such as tritium formation. A common thread weaving through all positive experiments with light water or hydrogen must be the strings (chains) of protons themselves. These odd experimental findings suggest that proton chains must be more compact than deuteron chains to result in reactions. Normally, palladium does not build concentrated proton chains as efficiently as deuteron chains - chains of equally spaced protons and deuterons are not equal. (Nickel does build straight, close-unit chains of protons better.) Dr. Yamaguchi's method of forming "accumulation layers" in coated palladium promotes crowded chains of protons as well as deuterons - at least impulsively to produce bursts of energy.

Comparing the cavitation methods of Griggs or Potapov with Stringham /George, it is fair to conclude (or at least speculate) that, although their (Stringham /George) deuteron chains have had a chance to form, their proton chains (which need to be more compact) do not have enough time to form in the very rapid cycle of the ultrasound waves. The Griggs and Potapov methods of agitation create oscillations that are slow enough to build the transient proton chains in H_2O.

Chains And Domains

Organization of matter is actually organization of energy, since matter is condensed or focused energy. What we call "structure" (e.g. metal lattice, molecules in a liquid) is a manifestation of the assembly of "energy bands" (ref. T. Chubb) of the electromagnetic - particle field which consists of multiple frequencies and harmonics. The energy bands or states are stable - and the imbedded "material" is stable - to the extent that the energy bands are self - resonant. The condensed form of energy we call matter, therefore, is an alignment (yielding a "structure") of various energy bands (which have linear propagation, it is proposed) that are collected into *coherent domains* (credit G. Preparata) of variable size. The degree or extent of coherency of a body is termed entropy (rather, *anti*entropy). That is, greater coherency of the energy bands and their domains equals lower entropy.

The consequence of these coherent energy bands is to describe macroscopic thermodynamic properties as being related to "the existence of long range electrodynamic interactions [the energy bands themselves] which are able to organize atomic systems on large scales [the coherent domains]. A purely atomic description of condensed matter appears untenable"[16].

A body at low entropy consists of fewer (but larger) coherent domains as well as fewer possible energy bands that can be occupied. A body at high entropy consists of more and smaller coherent domains and has a greater number of possible energy states.

A coherent domain is thought of as a region of the quantum field - - the electromagnetic - particle field - - that is resonant for a period of time, t, and which contains a resonant energy band over a distance, d, for that time, t. The domain may be occupied or unoccupied by "particles". If the energy band is occupied by particles, those particles act as one entity, one macroscopic quantum element. In this context, substances consist of particles that do not act alone but belong to one or another coherent domain. So, the behavior of individual atoms or molecules has no practical meaning. The responsibility for the macroscopic description of a body lies with the states (number, size, energies) of the coherent domains.

This description of properties of matter based on coherent domains is applied to the oscillating strings or chains of deuterons (or protons) in cold fusion cells. For example, a non-loaded palladium lattice, which itself consists of an arrangement of coherent domains having specific energy bands, also contains unoccupied energy bands which could be filled by hydrogen nuclei when the lattice domains are loaded. When this is done, the collective linear assembly of the hydrogen nuclei is also described as a coherent domain - a macroscopic quantum element - existing in the predisposed (excited) conduction band of the lattice, which is now filled. However, these hydrogen nuclei (which are likely at the surface or near surface) are not bound to the lattice but to the energy band which had been "reserved" for them.

Liquids also consist of coherent domains (albeit smaller size) of specific energy bands in a string like fashion multiplied over and over. Thus, it is perhaps not unusual that hydrogen on or near the surface of a metal lattice (the active sites) will migrate and oscillate as a "proton liquid" within a quantum energy band.

A suggestion of this kind was given by C. Battolomeo, M. Fleischmann, et al., in a paper at ICCF4 in Hawaii [17]. The authors point out that, "The protons (or deuterons) are in a collective state described by macroscopic quantum mechanics so that they can experience intense anharmonic excitations."

The reviewer of this ICCF4 paper (in "Cold Fusion" #5) speculates that "one consequence of this logic is that there is a way for collective proton liquid like

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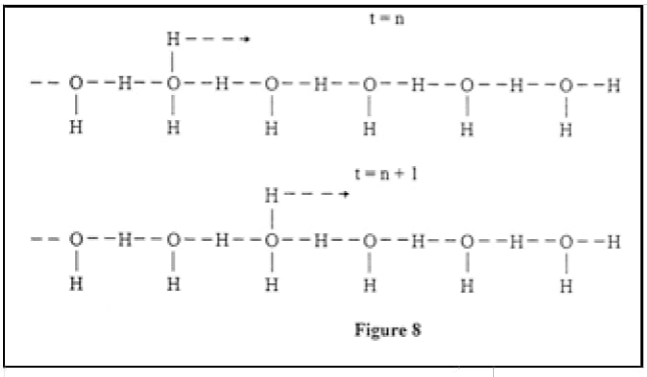

Figure 8

motions to build up to a point where energies sufficient to cause nuclear reactions to take place are available just as ocean waves build up into noisy breakers with much energy in them on a beach."

"Waves on a beach" is a good illustration of what is proposed to be happening within the chains of hydrogen nuclei, that is the basis of this entire theoretical model in cold fusion. Collectively, ocean waves add up to a complete ocean (most waves propagating under the surface, of course). And it is a fortunate thing that the waves of the ocean are divided into many zillions of smaller coherent domains and that the ocean is not "one giant quantum element" – though some avid surfers might not agree!

In a recent paper, William S. Page treats liquid water in the context of proton conductors [18]. His concepts seem to parallel ideas presented in this and the previous article[1], in which linear chains of deuterons or protons, at or near the cathode surface, are considered to be a single, mobile (conducting) entity.

Dr. Page writes:

"In any situation in which a particle moves in a periodic potential, the energy states of that particle are constrained to occur in "bands", i.e. groups of closely spaced discrete energy levels separated by "gaps" or forbidden energies. Each band contains the same number of states – equal to the total number of unit cells in the "lattice", i.e. the number of potential wells in the periodic structure... The lowest energy band is called the valence band. It is the valence band that is responsible for the structural stability of the material. Since protons are spin 1/2 particles, Fermi's exclusion principle allows for two such particles (in opposite spin states) to occupy each energy level. In the case of water, each unit cell (molecule) contributes two protons to the valence band. Therefore, as in the theory of electronic semi-conductors, we can see qualitatively that at absolute zero temperature water should be a proton insulator. All the potentially mobile protons would be in the valence band and this band would be full – a moderate potential difference is not able to change the energy level of (that is, to accelerate) these protons. At 0 K, the higher energy bands (the conduction bands) are all empty. As the temperature is increased, a small number of the protons from the valence band can be excited across the energy gap into the conduction bands (or equivalently, we say that auto-ionization occurs: $2H_2O \Leftrightarrow H_3O^+ + OH^-$)."

Dr. Page then illustrates a linear chain of water molecules and the movement of protons along this chain:

Such proton movement will account for the conductivity of water. In cold fusion cells, it is the conduction (actually, oscillations) of chains of protons against metal-atom barriers that has been proposed to be the cause of essentially all cold fusion effects, when the leading hydrogen nuclei enter windows I – VI.

Predictions Fulfilled Soon

The development of the theory presented in this paper and in the earlier article [1] has benefited immeasurably from a wide spectrum of consistent, albeit bizarre, data from a great variety of experiments. Also beneficial have been the important and insightful theoretical concepts written by creative thinkers in cold fusion. I have tried to understand what I can.

Yes, a few of the proposals are quite speculative, but testable. However, one prediction is probably above speculation: that missile engineers in the future will have a new kind of rocket to get excited about. And I am looking forward to the day when I can drive my new Fiat Fusion electric car into the service station to fill up with the world's new auto fuel – using an eye dropper!

Then the predictions given at the International Conference on Peaceful Uses of Atomic Energy (Geneva, Switzerland, August, 1955) will have been fulfilled [19]:

"When we learn how to liberate fusion energy in a controlled manner, the energy problems of the world will truly have been solved forever, for the fuel will be as plentiful as the heavy water in the oceans."

–Professor Homi J. Bhabha, then head of India's Atomic Energy Commission, and president of the Conference.

"My faith in the creative ability of the scientist is so great that I am sure that this [power from fusion] will be achieved long before it is essential for man's needs."

– Sir John D. Cockcroft (with E.T.S. Walton produced first artificial transmutation by man – made projectiles, 1932).

Dr. Cockcroft was nearly correct. Cold fusion is being achieved not long before the need – for the need is here. And the form (cold, not hot) is different than perhaps originally envisioned. Nevertheless, fusion has arrived! So, congratulations are in order, first to Martin Fleischmann and Stanley Pons, then of course ... et al.

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Cold Fusion Resource Guide 1996

Frequently Asked Questions About Cold Fusion

I thought cold fusion was dead — proved to be a mistake or a hoax. Is cold fusion research really still going on?

Cold fusion, the "miracle or mistake," that was announced at the University of Utah by Drs. Martin Fleischmann and Stanley Pons in March 1989 is far from dead. It is alive not only in dozens of laboratories in the United States, but in numerous foreign research centers, particularly in Japan. Cold fusion research is now a worldwide activity in over a dozen countries. It is now moving rapidly into the commercial development phase.

What is "cold fusion"?

"Cold fusion" is a real but still incompletely explained energy-producing phenomenon, that occurs when ordinary hydrogen and the special form of hydrogen called deuterium are brought together with metals, such as palladium, titanium, and nickel. Usually, some triggering mechanism, such as electricity or acoustic energy, is required to provoke the "cold fusion" effects. Both ordinary hydrogen and deuterium are abundant in ordinary water — whether fresh water, ocean water, ice, or snow—so the process will end many of the world's energy concerns, if it can be developed commercially. Now this is all but certain. (The deuterium form of hydrogen is present naturally as one out of every 7,000 hydrogen atoms and is easy and econmical to separate.)

Are there good sources of information about cold fusion?

If you would like to read about the evolution of this scientific controversy and the impending technological revolution, please read *Fire from Ice: Searching for the Truth Behind the Cold Fusion Furor* (John Wiley & Sons, May, 1991), by Dr. Eugene F. Mallove. This work, which Arthur C. Clarke has called "the only good book on the subject," covers the first two years of the cold fusion era. For more technical information, consult back issues of *Infinite Energy* and the reference sections of this *Resource Guide*.

What is "hot" fusion?

Hot fusion is the kind of nuclear reaction that powers the Sun and the stars. At temperatures of millions of degrees, the nuclei of hydrogen atoms can overcome their natural tendency to repel one another and join or fuse to form helium nuclei. This releases enormous energy. Fusion is the opposite of fission, which is the release of energy by splitting heavy uranium or plutonium nuclei.

What is the present status of "hot" fusion?

Scientists the world over have spent more than four decades and billions of dollars (an estimated $15 billion in the U.S. alone) to investigate the possibility of mimicking with devices here on Earth the fusion reactions of the stars. These are complex and large machines that rely on high magnetic fields or powerful lasers to compress and heat fusion fuel —typically the isotopes of hydrogen, deuterium and tritium. The controlled hot fusion program has made enormous strides, but all agree that the earliest possible time when practical hot fusion devices might be available is about three decades away. Hot fusion is a very tough engineering problem. Many engineers—even those favorable to hot fusion—suggest that the "tokamak" reactor approach being followed by the U.S. Department of Energy will never result in commercially viable technology.

The U.S. hot fusion people now want to build a big, complex test reactor called ITER (International Thermonuclear Experimental Reactor), which might begin to operate in 2005. A commercial hot fusion power plant would not be on-line until at least 2040. The annual budget for hot fusion research in the U.S. regularly has exceeded $500 million, and the program now seek increased funding for ITER and other experiments. However, in 1995 the U.S. Congress dramatically scaled back the annual magnetic confinement hot fusion budget from about $340 million to $240 million. Many observers believe that this is the beginning of the end for the hot fusion program in the United States. Yet no one should underestimate the ability of this monolithic, bureaucratic Federal program to continue to waste money on doomed projects while cold fusion continues to be ignored by the U.S. Department of Energy (DOE).

How does cold fusion differ from hot fusion?

Cold fusion releases enormous quantities of energy in the form of heat, not radiation, as in hot fusion. This heat energy is hundreds to thousands of times what ordinary chemical reactions could possibly yield. If "cold fusion" is a heretofore unknown form of benign nuclear reaction—as many researchers in the cold fusion field believe—there is more potential cold fusion energy in a cubic mile of sea water than in all of the oil reserves on earth. (This is true if the cold fusion "fuel" is deuterium, the non-radioactive naturally occurring isotope of hydrogen.) Cold fusion, in contrast to hot fusion, occurs in relatively simple apparatus, albeit not yet without some difficulties. Cold fusion reactions are not at all like conventional hot fusion reactions. If they were, cold fusion experimenters would have been killed by massive flows of radiation—neutrons and gamma rays. The continuing wonder of cold fusion is that —whatever it is— it is apparently a very clean reaction that gives very little of the radiation common to fission and fusion reactions.

Are there theories that can explain "cold fusion"?

Cold fusion researchers have attempted to find theoretical models to explain the observed cold fusion effects—the large thermal energy releases, the low-level nuclear phenomena, and the absence of massive harmful radiation and other conventional nuclear effects. In cold fusion

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experiments, low-level neutrons, tritium, helium-4, and isotope shifts of metal elements have been seen. There is yet no single, generally accepted theory that explains all these phenomena. There is no doubt, however, that the phenomena exist and will eventually be explained —most likely in the next few years. It is very hard, however, to come up with a theory that fits all the data. The explanation might lie in nuclear reactions, exotic "super-chemistry" requiring some modifications to quantum mechanics, or something even more bizarre (such as tapping of the zero-point energy of space at the atomic level).

What is the main evidence for "cold fusion"?

The most important evidence for cold fusion is the excess heat energy that comes from special electrochemical cells—much more heat coming out than electrical energy being fed in. Competent and careful researchers have now confirmed that under the proper conditions it is possible to obtain excess power output beyond input power anywhere from 10% beyond input to *many thousands of times the input power!*. In fact, in experiments reported at the Fourth International Conference on Cold Fusion (December, 1993), one researcher, Dr. T. Mizuno of Hokkaido University, reported an output/input power ratio of 70,000. Sometimes this power comes out in bursts, but it has also appeared continuously in some experiments for hundreds of hours and in some cases even for many months. When this power is added up to give kilowatt-hours, the inescapable conclusion is that much more energy is being released than any possible chemical reaction (as we ordinarily understand such reactions) could yield.

And there is more: In the past few years, there has also emerged a startling body of experimental evidence that elements have been *transmuted* in cold fusion experiments. Helium-4, for example, has been found by several laboratories, and low levels of radioactive metal atoms, e.g isotopes of silver and rhodium, have appeared in palladium electrodes from cold fusion cells where no such atoms existed before the experiments began.

How can we be sure that the cold fusion heat-measuring experiments are not mistaken?

Many of these cold fusion experiments differ significantly from one another in their approach and conditions. So there is no chance that the various laboratories are all making the same systematic errors in *all* these experiments. The excess energy in some of these experiments is proof that something very extraordinary and of enormous potential technological significance has been discovered. In the early days of cold fusion research, when scientists were struggling and learning how to replicate the effect, there were many poorly done experiments, and many mistakes. In the weeks following the 1989 announcement by Drs. Martin Fleischmann and Stanley Pons at the University of Utah, large numbers of scientists tried to replicate the phenomenon, and failed—or *thought* they had failed, but actually might have obtained positive results but for various reasons falsely interpreted and improperly reported their data. The experiment is considerably more complicated and difficult to perform than originally reported in some scientific and popular news journals. The possible measurement error in many cold fusion experiments today are much, much smaller than the huge effects being measured.

Are there other ways of getting excess energy in "cold fusion"?

The original cold fusion experiment of Drs. Fleischmann and Pons has now been joined by many other methods to obtain excess energy. This is the current (and growing) list of apparent "cold fusion" processes giving excess energy:

1. The Original Pons-Fleischmann Process

Heavy water solution with a current-carrying electrolyte such as lithium deuteroxide (LiOD). Current is passed between a palladium or palladium-alloy cathode and a platinum anode.

2. Molten Salt Process

High-temperature molten electrolysis process involving typically lithium chloride (LiCl) and potassium chloride (KCl) molten solution saturated with lithium deuteride (LiD). Electrodes of palladium and aluminum.

3. The Randell Mills Process

Ordinary water solution with (typically) potassium carbonate (K_2CO_3) electrolyte. Electrodes: nickel cathode and platinum or even nickel anode.

4. Deuterium Gas Discharge Process

Low voltage electrical discharge onto various metals through a deuterium gas atmosphere.

5. Ultrasonic Activation

Using ultrasonic frequencies, acoustic energy bombards palladium or other metal submerged in heavy water, producing excess energy and helium-4.

6. Ceramic Proton Conductors

Certain ceramic materials such as strontium-cerium-oxide and aluminum-lanthanum-oxide, when very low current is passed through them in a deuterium gas atmosphere, give significant excess energy.

7. Magnetic Field and Radio Frequency Stimulation

Magnetic fields and radio-frequency stimulation have now been proved to enhance the excess energy from other cold fusion processes, e.g. electrochemical cold fusion cells.

8. Turbulent Activation

A massive aluminum cylinder with a geometric hole pattern on its periphery rotates at close tolerances within a steel casing. Ordinary water is pumped through the interface and is heated or flashes to steam. The Hydrosonic Pump (of Hydro Dynamics, Inc.) has now shown convincing evidence of massive excess power production. Similar devices have been reported by others.

9. Piantelli-Habel-Focardi Process

A nickel substrate is subjected to high temperatures in a hydrogen atmosphere. Process details have not been released, but evidence for massive excess energy production is clear.

10. The Patterson Process

Dr. James Patterson received the first U.S. patent for a cold fusion cell. His cell uses small beads (plastic or perhaps metallic) coated with various metals. Typically, a Patterson Power Cell is run with ordinary water and an electrolyte such as Li_2SO_4. This is a highly reproducible process—a direct lineal decendant of the Pons & Fleischmann cell.

11. and Beyond!

It seems very proabable that even more instances of "cold fusion" processes will be found. For example, there is a group of investigators in the U.S. mid-west (which prefers to be unidentified for the time being), that has apparently discovered an electro-chemical-arc process that exceeds 1,000 °C. Preliminary work indicates that the process produces more energy out than input. The process readily melts and boils ceramic tile or quartz material

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Which laboratories are getting positive results?

Several hundred laboratories around the world have obtained positive cold fusion results. A partial list, which appeared in *Fire from Ice* in 1991, is already outdated. In the spring of 1991, a conference in the former Soviet Union revealed many more positive results; at the Second Annual Conference on Cold Fusion held in Como, Italy, in July 1991, much more positive evidence for cold fusion emerged. At the Third International Conference on Cold Fusion in October, 1992, the evidence became completely overwhelming. At the Fourth International Conference on Cold Fusion (Maui, December, 1993), the field blossomed in many new directions: new methods of generating excess power, and new observations — especially *the apparent transmutation of heavy elements at low-energy*. At the Fifth International Conference on Cold Fusion (ICCF5) in Monte Carlo, Monaco (April 1995) a Patterson Power Cell was run continuously during the conference, producing unambiguous excess energy at a power ratio on the order of 5/1 to 10/1. The evidence of heavy element transmutation continued to build dramatically. Research facilities reporting important cold fusion results include:

- Electric Power Research Institute (EPRI)/Stanford Research Institute (SRI)
- Los Alamos National Laboratory
- Oak Ridge National Laboratory
- Naval Weapons Center at China Lake
- Naval Research Laboratory
- Naval Ocean Systems Center
- Texas A&M University
- California State Polytechnic University
- ENECO, Salt Lake City
- Hokkaido National University
- ENEA (Italy)
- National Institute for Nuclear Physics (Italy)
- Osaka National University
- National Institute for Fusion Science, Nagoya
- Tokyo Institute of Technology
- Bhabha Atomic Research Centre, Bombay, India
- Technova Corporation
- IMRA Corporation
- NTT (Nippon Telephone and Telegraph company)
- E-Quest Sciences (California)
- Shell Recherche SA (France)
- Tsinghua University (China)
- University of Illinois at Urbana
- Clean Energy Technologies, Inc. (Dallas, Texas)
- JET Technology, Inc. (Wellesley Hills, MA)

Many other private research laboratories in the U.S. and abroad.

Who is funding cold fusion research and development?

Major financial support for cold fusion research comes from these sources:

The public announcement in December 1993 that ENECO, a Salt Lake City-based corporation, had acquired world-wide licensing rights to the University of Utah's cold fusion patents is further indication of the increasing corporate interest in cold fusion R&D. ENECO has now become one of the top funders of cold fusion research in the United States and abroad.

The Ministry of Education, Government of Japan. Research is coordinated through Japan's National Institute for Fusion Science, in Nagoya, and conducted in National University Laboratories. The Ministry of Education spends $15 to $20 million per year on cold fusion. In the Autumn of 1991, the Ministry of International Trade and Industry organized a research consortium of ten major Japanese corporations to advance research in cold fusion. Prior to this, only the Ministry of Education was involved in this research. This consortium is called "The New Hydrogen Energy Panel" (NHEP). In the spring of 1992, as the activities of the Panel became widely known, Japanese newspapers reported that five other major Japanese corporations asked to be included.

In mid-1992, MITI announced a four-year, three billion yen ($24 million) program to advance cold fusion research. This money was to be spent on special expenses within the national laboratories, such as travel and extra equipment purchases beyond the usual discretionary levels. That sum does not include the money, salaries and overhead, which come out of separate budgets, and it does not count any research in the private sector, which we know to be substantial. In fact, the corporate members are expected to contribute at least $4 million more to the fund, for a total of $28 million. Both MITI and NHEP members emphasize that this fund is flexible, and can be expanded. The present annual expenditure in Japan on cold fusion is estimated to approach $100 million. This will clearly rise dramatically as technological devices begin to emerge.

In 1995, Japan's New Energy Development Organization (NEDO) announced that it would increase its cold fusion funding to $100 million over the next four years.

In late 1995, it became known that the Motorola Corporation (a multi-billion dollar U.S. "Fortune-500" company) was trying to invest in Clean Energy Technologies, Inc. —reportedly offering that company over $10 million for a 100% buyout.

The Electric Power Research Institute (EPRI), Palo Alto, CA., (the $500-million/year research arm of the U.S. electric utility industry) had spent as of the end of 1991 $6 million on cold fusion, and had budgeted as of January, 1992 $12 million. The EPRI program continued to spend several million dollars per year. EPRI's sponsorship of the Fourth International Conference on Cold Fusion (December, 1993) means that this powerful research organization was solidly in the field. However, in 1995 major cutbacks in research at EPRI— across-the-board in many nuclear and advanced energy areas— led to the dramatic reduction in cold fusion funding by EPRI. The Japanese NEDO organization then took over the task of funding SRI International's cold fusion work, formerly funded by EPRI.

What about the ordinary water — non-heavy water — cold fusion experiments that I have heard about?

These ordinary water experiments were first reported in May, 1991 and have since been widely reproduced—in Japan, India, and in the United States.

Dr. Randell Mills of Hydrocatalysis Power Corporation, of Lancaster, PA, whose heat-producing experiments with cells with ordinary water, potassium carbonate electrolyte and nickel cathodes are increasingly highly regarded in the cold fusion field. Dr. Mills made a presentation at the May 5, 1993 Congressional hearing before the House Science, Space, and Technology Committee. Mills's opening remarks concisely summarized what the important Lancaster, PA effort is all about:

"Hydrocatalysis Power Corporation (HPC) has an extensive theoretical and experimental research program of producing energy from light-water electrolytic cells. HPC and Thermacore, Inc., Lancaster, PA are cooperating in developing a commercial product. (Thermacore is a well-respected defense contractor and its expertise is in the field of heat transfer.) Presently, all of the demonstration cells of HPC and Thermacore produce excess

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power immediately and continuously. Cells producing 50 watts of excess power and greater have been in operation for more than one year. Some cells can produce 10 times more heat power than the total electrical power input to the cell. A steam-producing prototype cell has been successfully tested. ....The [original] experiment has been scaled up by a factor of one-thousand, and the scaled-up heat cell results have been independently confirmed by Thermacore, Inc. Patents covering the compositions of matter, structures, and methods of the HydroCatalysis process have been filed by HPC worldwide with a priority date of April 21, 1989. HPC and Thermacore are presently fabricating a steam-producing demonstration cell."

Of course, the increased prominence now of the Patterson Power Cell, which also uses light water electrolyte, is dramatic proof that non-heavy water cells can produce massive excess energy.

What does Dr. Mills think is behind this ordinary water energy source?
Dr. Mills and his colleagues believe that the energy source in their ordinary water experiments is technologically extremely potent, but they have adopted a radical theory to explain the excess heat. Dr. Mills says that the source of excess energy is released in a catalytic process whereby the electron of the hydrogen atom is induced to undergo a transition to a lower electronic energy level than the "ground state" as defined by the usual quantum-mechanical model of the atom. Thus, stored energy in the atom is catalytically released. Mills views many of the nuclear effects in "cold fusion" to be real effects, which he thinks can be explained by his theory.

Are cold fusion experiments generally reproducible?
Cold fusion effects have not always been easy to reproduce, but that does not make them any less real. The difficulties with reproducibility, however, are very rapidly disappearing as researchers discover the conditions required to provoke the phenomena, such as sufficient deuterium loading of metal lattices, specific metallurgical requirements, and peculiar triggering mechanisms. Some experimenters now report very regular appearances of cold fusion phenomena, such as neutron bursts, tritium production, and excess power as exhibited by heating, boiling, and even a phenomenon called "heat after death," in which the heat output of an electrochemical cold fusion cell continues unabated for many hours or days after input electric power has been terminated!

Critics of cold fusion research have regularly dismissed positive results simply because the effects have not always been repeatable. This is a remarkably naive view! Of course there are many natural phenomena that are highly erratic, not repeatable, and definitely not predictable, such as meteorite falls, lightning strikes, earthquakes, and the elusive "ball lightning." There are also a host of modern technical devices that will not function if subtle, sometimes poorly understood composition parameters are askew; semiconductor electronic devices are good examples of this. It is not so surprising that the exotic cold fusion phenomena are occasionally subject to similar difficulties.

What about the experiments of Caltech, MIT, and Harwell that supposedly found no excess heat in 1989? Aren't these very damning to the cause of cold fusion?
It is shocking but true, but in the case of three major research groups that had supposedly negative results in the spring and summer of 1989 —Caltech, the Harwell Laboratory in England, and MIT Plasma Fusion Center—there now appear to be significant questions about their work, which have not been addressed by the scientific community. Three scientists have found simple algebraic and other fundamental experimental errors in the Caltech work, which invalidate the paper's negative conclusions. These scientists wrote many times to *Nature* magazine, but *Nature* refused to publish these corrections, so a critique was published in *Fusion Technology*. In the MIT Plasma Fusion Center case, serious questions about the methods used to evaluate excess heat results have arisen. The unpublished data appear to show indications of excess heat, but the published version does not show these indications. Furthermore, analysis of the methodology employed by this group revealed fatal flaws — even *if* the data had been properly handled. A technical discussion of the 1989 MIT Plasma Fusion Center cold fusion calorimetry appeared in *Fusion Facts*, August, 1992, authored by Dr. Mitchell R. Swartz of JET Technology. In the case of the widely-touted and supposedly completely "negative" Harwell Laboratory (U.K.) calorimetry results, independent analysis of that laboratory's raw data show evidence of excess heat production. The details of the Harwell Laboratory problems have now been published in both the Third and Fourth International Conference on Cold Fusion *Proceedings*.

Do we need to understand cold fusion to begin to develop it commercially?
When conventional (low temperature) superconductivity was discovered accidentally in 1911, there was no physical theory that could explain it, nor was there any such theory for about the next half century. The much discussed high-temperature superconductivity, which appeared in 1986-1987, still has no satisfactory theory to account for it. Yet industries and governments are bent on developing and commercializing it. The same should be true for cold fusion. However, because cold fusion seems to be an even more radical departure from conventional physics wisdom than high temperature superconductivity, and because of the past reproducibility problems of cold fusion, the latter has not been accepted as readily as high-temperature superconductivity.

Is there a future for cold fusion?
Cold fusion research is not "Big Science" —it does not need massive installations, just relatively small-scale dedicated work at national laboratories, universities, and in private industries, which are already beginning to enter the field in the U.S., despite discouragement from officialdom. Cold fusion does, however, require the talents of top scientists and engineers, combined with sophisticated analytical instrumentation. The federal laboratories are well-equipped to support cold fusion research. They are floundering in search of a new mission. Cold fusion research could well become a major mission for scientists at these laboratories.

Cold fusion energy development will dominantly be the territory for private industry. There is no need for massive government investment. But government should smooth the path for private efforts. Is it really possible that a revolutionary energy technology has been inappropriately cast aside in the U.S.? That is exactly what has happened, as scientific and engineering developments will show. This need not be true any longer. For the economic and environmental well-being of the nation and the world, every citizen must become aware of the facts about cold fusion and help encourage funding for American and world-wide research.

Probably the most difficult hurdle in

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trying to come to terms with cold fusion is that it seems too fantastic scientifically, and "too good to be true" economically and socially. But the same could have been and was said about many other technological revolutions as they began to happen. Cold fusion and allied discoveries will likely revolutionize the world in ways we can barely begin to imagine. We believe that before the year 2000 there will be cold fusion powered automobiles, home heating systems, small compact electrical generating units, and aerospace applications. These technologies will revolutionize the world as they speed the end of the Fossil Fuel Age. The stakes have never been higher. We should remember the sentiment of the famous scientist, Michael Faraday, in the last century, to whom we owe our revolutionary electrically powered civilization. He wrote,

"Nothing is too wonderful to be true..."

Cold Fusion: What it Does

by Jed Rothwell

An edited version of a talk given at the Global Super Project Conference & Exhibition in Barcelona, Spain, June 19-22, 1994. The theme was "Building Teams for Billion-Dollar Projects."

Abstract

In 1989, cold fusion cells produced intermittent power at a fraction of a watt. Today, some produce steady output at levels as high as 150 watts. Some are fully ignited; that is, they are self-sustaining, with no electric input. The early cells produced low power that was difficult to detect, while the best cells today produce massive, macroscopic power that is impossible to miss. Cold fusion cells have generated thousands of times more energy than any chemical reaction could. The effect is probably capable of producing millions of times more energy than chemistry.

Rapid progress has prompted MITI, Toyota, EPRI, and others to expand R&D efforts in recent years. This will probably lead to prototype generators, space heaters, and automobile engines before the end of the century. Unless some unforeseeable, last minute problem arises, cold fusion will be commercialized. Within a generation it will bankrupt conventional energy suppliers, and bring about revolutionary changes in many areas of technology.

This lecture is titled "Cold fusion: What it does," because I do not know what cold fusion is. I do not know what it is on the sub-atomic level, but I know how it behaves macroscopically. I *can* describe the engineering performance characteristics of this new energy source: power density, fuel consumption, radioactive byproducts, and so on. Based upon these characteristics, I can predict what kinds of products will soon appear.

First, some history

Cold fusion was announced at the University of Utah in March 1989 by professors Martin Fleischmann and Stanley Pons[1]. The announcement caused the biggest brouhaha in the history of modern science. It was harshly criticized by most leading scientific journals and institutions[2,3], and a few months later it abruptly vanished from the U.S. media. Most people then assumed that it was a mistake. People now assume that the experiments were never replicated, and that no experiments are being performed today. But cold fusion did not disappear. The experiments *were* replicated. Pons and Fleischmann settled in France where a Toyota Motor Company think tank built for them a splendid, 50,000 square-foot cold fusion research institute. Behind the scenes in Japan, Italy, Russia, and in many labs in the U.S., including Los Alamos, there are now more solid, credible, important experiments being performed and published than ever before. MIT's *Technology Review* for the May/June 1994 issue features a superb article about cold fusion[4]. The magazine cover shows an idea that was thrown in the trash can, and is about to re-emerge.

The Third International Conference on Cold Fusion was held in 1992 in Nagoya Japan. The sponsors, among them, The Physical Society of Japan, The Japan Society of Applied Physics, the IEEE comprise an impressive list[5]. In December 1993, the Fourth International Conference was sponsored by the Electric Power Research Institute (EPRI). During that conference in Maui, Japan's Ministry of International Trade and Industry announced expanded support for cold fusion, including a new dedicated lab and a $30 million, four-year program [6]. Since 1989, tremendous progress has been made at the leading laboratories. We have progressed from cells that produced a fraction of a watt intermittently to cells that produce hundreds of watts continuously for days.

Two certainties

It is important to make two scientific points about cold fusion:

1. The effect *does* exist. Experimental error has been ruled out.
2. Cold fusion cannot possibly be a chemical form of energy.

Five years ago, the level of heat was so low it could barely be detected with sensitive laboratory instruments. These tiny flickers of heat might have been caused by experimental error, poorly calibrated equipment, or wishful thinking. Experimental errors might have explained the 1989 results.

Today, the leading laboratories routinely see reactions ranging from 30–150 watts or more—some with no electric power input[7,8]. Such powerful reactions are dead simple to detect. They produce very high temperatures. Try holding your hand over a 150 watt light bulb and you will see what I mean. Cold fusion scientists observe obvious, macroscopic heat effects. At Toyota, they boil water, and the cathodes remain hot long after that with no input[7,9]. If there were no cold fusion effect, the cathodes would quickly cool to room temperature.

Some skeptical scientists claim that all excess heat measurements are due to experimental error. What does this assertion mean? What these skeptics are really saying is that Toyota cannot tell the difference between boiling water and water at room temperature. They are asserting that hundreds of scientists worldwide cannot measure temperatures ranging as high as 200°C. Figure 1 shows data from Mizuno et al. of Hokkaido University. Ten hours after the reaction begins, the cell temperature is 400°C. The calibration shows that if there were no reaction, the temperature would be 270°C. That is 130°C, a gigantic difference!

The Hokkaido scientists spend a month calibrating and checking their equipment before they do these experiments. They employ three types of control experiments that show no trace of excess heat. An error, something like a loose wire, could not possibly hide during calibration, hide during the control experiments, and then suddenly produce such dramatic effects with the ceramic material in deuterium only.

The notion that all reported results could be caused by systematic errors flies in the face of the scientific method. If it were possible for hundreds of scientists to make gross errors year after year, mismeasuring temperatures by 100°C in experiment after

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experiment, then science would not work—and we would still live in trees.

My second point is that we are now certain that cold fusion is not a chemical source of energy. It produces thousands of times more energy than any chemical reaction ever could. A half-gram of the most concentrated chemical fuel will burn at 70 watts for four minutes; half-gram cold fusion cathodes sometimes generate heat at that rate for hours, some go for days. Cold fusion cannot be any type of chemical battery storage; the 16 gram Piantelli device produced as much energy as 320 automobile batteries. (In U.S. units: a half-ounce gadget generated as much energy as 9,000 pounds of batteries.)

"Anomalous heat production in Ni-H systems"*Il Nuovo Cimento*, Vol. 107 A, N. 1 pp.163–167, S. Focardi (U. Bologna, INFN), R. Habel (U. Cagliari, INFN) and F. Piantelli (U. of Siena, INFN).

Three sample runs from 1993:

Highest power:	
57 watts for 20 days	98.5 MJ
	3.5 watts/cm^2
Longest:	
27 watts for 100 days	320 MJ
	2.3 watts/cm^2
Example cited in paper:	
44 watts for 24 days	91.2 MJ
	2.7 watts/cm^2

[MJ = mega-joule]

Here is some 1992 data from Pons and Fleischmann (Fig 2)[7,9]. This is the temperature of a cell that was driven to boiling by heat from the cold fusion reaction. At this stage, all of the electrolyte has boiled out, and the connection between anode and cathode is broken, so no additional electrical energy can go into the cell.

As you see, it stays hot for three hours. This phenomenon is known as "heat after death" or "a fully ignited, self-sustaining" reaction. If there were no cold fusion heat, tests show that the temperature would drop very rapidly. This should be intuitively obvious: the cathode is a half-gram metal rod, like a small nail. Without some source of energy to keep it hot, a small nail in a half-silvered Dewar will cool down very rapidly.

During the three-hour period it remains hot, and the cathode generates 128,500 joules. The absolute maximum potential chemical energy in the cell is the 660 joules that might be released by combustion of the deuterium in the cathode. The cell has generated 200 times more energy than any chemical reaction could. There can be no stored up chemical or physical energy hidden in the cell, because it already generated excess heat for a week before this point, including 86,700 joules in the 10-minute boil-off just before the power cut off.

Cold fusion is nuclear, sort of . . .

We often assume cold fusion must be nuclear, because no other source of energy could produce so much heat from such a small amount of fuel. We think it is some kind of fusion, because it produces tritium and helium. On the other hand, it does not produce a deadly flux of neutrons, so it cannot be the type of nuclear fusion that occurs in the sun.

Scientists do not know what to make of it. They theorize, hypothesize, argue, and debate. Some scientists say that because the reaction is theoretically impossible, it cannot be happening. They believe that textbook theories overrule facts. They are like the proverbial professor of aerodynamics who insists that bumblebees cannot fly. You must not get dragged into sterile, academic debates with these people about neutrons. To evaluate the reality of cold fusion, it is best to ignore nuclear physics, and stick with simple, concrete, 19th century physics.

Look at calorimetry: power in, heat out, power density, net excess energy; simple, classical physics—the bread and butter of engineering. If you concentrate on that, you will understand what it means when Piantelli reports a stable, 400°C, 30 watt reaction that runs for 100 days, adding up to 320 megajoules of energy from 16 grams of nickel. It means that if he can scale up that reaction, he could put Exxon out of business.

That is the point! Toyota, MITI, EPRI, and the others are spending money on this research to "put Exxon and OPEC out of business." They are not interested in funding esoteric debates about neutrons. There is no market for neutrons except in government-funded hot fusion research; nobody wants to buy them. Toyota wants concentrated, industrial strength heat. Their cathodes yield 4,000 watts per cubic centimeter, which is better power density than a fission breeder reactor. High temperatures have been reached, and Carnot efficiency is excellent in some cells.

Virtually free fuel?

Cold fusion produces massive, concentrated heat energy from water! The fuel is virtually free. A kilogram of heavy water in a cold fusion device will probably produce at least 2.7 million times more energy than a kilogram of oil. To put it another way, your car will go 55 million miles on a gallon of heavy water. The metals used in many cold fusion experiments are cheap and abundant. Some 1989 experiments used palladium, which is expensive; others used titanium which is cheap. Recent experiments have used nickel, ceramic compounds, tungsten-bronze, and other host metals.

The reaction produces no measurable levels of pollution or radiation. The cells input hydrogen and output helium, an inert, harmless gas which is already present in the atmosphere. If all of the energy in the world were produced by cold fusion, it would add a few tons of helium to the atmosphere per year. Some cells do produce worrisome levels of tritium, but others do not produce any measurable tritium at all.

There must be some controlling factor which turns on the tritium production under certain conditions. When the scientists finally learn how cold fusion works, they will learn to turn off tritium, just as today we prevent fires from generating excessive smoke from insufficient combustion. Cold fusion does produce neutrons, charged particles, and other byproducts of a nuclear reaction—but they can be contained with modest shielding.

The 64 trillion dollar question is: Can Piantelli scale up the reaction? The Italian newspapers report that he is working in cooperation with the Fiat Motor Company. Will Fiat put Exxon out of business? If Piantelli cannot do it, can Mizuno, or McKubre, Miles, Mills, Pons & Fleischmann, or someone else?

Can the reaction be controlled and scaled up? I see no reason why not. There are no insurmountable roadblocks. Progress has been swift, and power levels are thousands of times higher than they were a few years ago. Piantelli, who achieved 60 watts last year, is reportedly preparing to test a 1,000 watt cell. If he succeeds he will soon go to 10,000 watts—enough to power a prototype Fiat automobile.

I have spent 20 years building new products with cutting edge technology. Painful lessons have taught me never to count my chickens before they hatch. So, I cannot be absolutely certain that cold fusion will pan out, and I would not want to guess how long it will take. This is brand new science. It is like designing and building a computer from scratch: Start with a bucket of sand, refine the silicon, etch the chips, build the circuits . . . it can be done, but it takes time.

What lies ahead?

In spite of the difficulties, we have made great progress. We are close to the goal. The stakes are high, for cold fusion will be worth countless hundreds of billions of dollars. I cannot imagine anything will

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stop scientists from finishing the job. Investment in cold fusion may still be risky, but a bet against cold fusion would be foolhardy. If you invest in oil, you are betting against cold fusion, and you are much braver than I.

Future prospects are rosy, but there are no practical devices yet. One experiment will yield high temperatures; another will continue for months at a modest temperature; a third produces excellent power density, only to die out after a few days. Put them all together in efficient, reliable, and controllable devices, and you have a potent source of energy. Nobody knows how to put them together yet, but we will learn. When one caveman finds you can rub sticks together to make a fire, another finds you can roast a pig in a fire, and a third invents a stone blade to cut firewood, eventually the three will get together and develop cooking.

A broad range of cold fusion cells will emerge from the laboratory. Some may be ideal for space heating or water heating, at modest temperatures. Others will work at thousands of degrees. These devices will allow a broad range of engines, generators, and heaters. A tiny thermoelectric power cell may be ideal for pacemakers and other medical devices. A glow discharge device may be right for jet aircraft engines.

One of the first cold fusion applications will be the automobile engine, and much else will follow from that. The company that brings out a cold fusion automobile will grab a gigantic share of the auto market, and make fantastic profits which it will invest in improving cold fusion technology. It will soon produce or license other products, like small home electric generators.

Cold fusion produces neither smoke or other pollution, nor does it need a tank of dangerous, explosive gasoline, so you can put a cold fusion reactor in your basement. Thermoelectric chips may be rapidly improved, allowing compact, rugged, maintenance-free, silent generators, with no moving parts. If thermoelectric chip prices do not fall, then some other equally quiet, convenient form of electric generation will soon be invented, because the economic incentive will be so great.

When a core technology improves radically, peripheral technology follows a few years later. After microprocessors appeared, smaller, cheaper, and better disks and printers soon followed.

Design engineers today must strive to make engine and generator fuel efficient. Over the lifetime of the engine, the cost of fuel exceeds the cost of the engine. There are design trade-offs: engineers must sacrifice simplicity, ease of maintenance, ruggedness; they must select expensive materials to get the most out of the fuel. With cold fusion, fuel efficiency hardly matters at all. A 12 percent efficient engine will be as good as a 30 percent efficient engine, as long as it is not too hot and bulky. Fuel cost will be zero in either case.

Designers will stop worrying about efficiency and concentrate on other desirable features instead, like a low capital cost for equipment, simplicity, and low maintenance cost. New designs will eventually allow cheaper motors than we have today. Competition will ensure that cold fusion automobiles will become cheaper than gasoline models.

The first home generator may cost $30,000, but prices will fall swiftly because the materials in most cold fusion cells are cheap, and the manufacturing process will be simple. Home generators will soon cost about as much as a deluxe central air conditioner and heater, which is $7,000 to $14,000 in Atlanta, Georgia. They may be co-generators that provide high grade heat for electricity and air conditioning, and waste heat for water and space heating during winter. Heat can be used in place of the compressor pump in a refrigerator or air conditioner.

Perhaps some of you will remember old-fashioned gas fired refrigerators. They remind us that heat can be used in many applications we tend to think call for electricity. The co-generator will eliminate the need for both electricity and gas. When people build new houses, offices, factories, and shopping malls, or when old water heaters, furnaces, and air conditioners wear out, people will replace them with co-generators, and they will go off the electric power network.

The electric power distribution network, and the power companies, will soon go out of business. There will be no need for central distribution of power. It exists today because it is safer, it pollutes less, and it is more fuel efficient which makes it cheaper. When fuel costs nothing, and there is no pollution, central power distribution will make no economic sense.

These hydroelectric mega-projects you have talked about will not be needed. In 30 years, existing hydroelectric dams will be abandoned, because it will not be worth maintaining the high tension wires from the dams to the cities. We will not need any more oil wells, pipelines, or supertankers. Only 19 percent of oil is used in non-energy applications. That's 11 million barrels a day world-wide. Local sources will suffice in many countries.

The U.S. will not import any oil from the Middle East when our consumption drops by 80 percent. I predict that in the distant future this 11 million barrels per day will drop to zero, as chemists learn to synthesize petrochemicals out of hydrogen and carbon, the carbon from carbon dioxide in air. That will require a fantastic amount of energy, because it takes much more energy to synthesize a kilogram of oil than you get from burning a kilogram, but it will not matter when energy is free. It will be safer and cheaper to synthesize oil for petrochemicals on site with automated machines, rather than shipping it around in trucks.

The revolution is on the horizon

I could go on talking about the ramifications of this revolution for the rest of the week and barely scratch the surface. Every industry uses energy. Nearly every product uses energy. When products are redesigned to take advantage of the new features and freedom this energy source will provide, many will be revolutionized and improved tremendously. At last we will have practical portable computers. Our aircraft will fly at full speed, no more "cruising speed" to preserve fuel. An airplane, hovercraft, or cruise missile will be able to circle the globe a hundred times without depleting its fuel supply. Agriculture will be revolutionized. Large scale distillation of ocean water may allow the deserts to bloom. Dazzling new products we cannot even imagine will suddenly appear.

The possibilities are mind-boggling. Every industry on earth will change, and eventually every person on earth will be affected. For one thing, the air will be clean again, because most air pollution comes from burning fossil fuel.

It will be many years before products take full advantage of cold fusion. It will take prodigious amounts of work and investment capital. The capital will come from consumers. They will be delighted to pay less for cold fusion automobiles than gasoline powered models, especially when the cold fusion autos will be more reliable, more powerful, and will never require fuel. When your old furnace wears out, you will be happy to spend a few thousand dollars extra on a new furnace and co-generator that saves you $150 or much more per month for gas and electricity.

The gradual changeover to cold fusion will not cost the consumers any more than they would have paid anyway, because all equipment wears out after 20 or 30 years. Most people will put off buying a cold fusion car until the old gasoline car wears out, or until the last gas station in the neighborhood goes out of business.

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This changeover will be the biggest technological mega-project in history. But it will not be a centralized, planned project. It will happen spontaneously, everywhere, without planning, without direction. It will be like the microcomputer explosion. Dozens of companies will sprout up, dozens of old ones will die off. Companies that sell energy conservation equipment will disappear, while new companies will blossom by selling things like flashlights that stay on for decades, welding equipment you do not have to plug in, and scuba diving equipment that never runs out of air because it extracts oxygen from water. Ideas, gadgets, and innovation will come from every direction, in a madcap free-for-all. It will be capitalism at its best.

Some people may try to stop cold fusion. Exxon, OPEC, and the DOE may fight to the bitter end (or they may finally join the cold fusion revolution!), but they do not stand a chance against MITI, Toyota, Hitachi, and the American consumer. The public will demand this marvelous, money-saving, pollution-free form of energy.

There is a strange objection I often hear. People say, "We have heard these empty promises before, 'power too cheap to meter.' Nuclear fission did not pan out, nothing can work that well. It is too good to be true." This is a myopic view of history. A person living 200 years ago would find our world filled with countless inventions and discoveries even more amazing than cold fusion, inventions which did pan out.

Electricity, nuclear reactors, hydrogen bombs, x-rays, unmanned exploration of other planets, antibiotics, television . . . our ancestors could never have imagined these things. Our personal computers perform millions of operations per second for years without skipping a beat. They can compute more sums in a few minutes than an ancient clerk or astronomer could have done in a lifetime. They are miracles of technology, unthinkable in any earlier age, yet our children use them to play games! We take for granted the blessings of science and technology—we have forgotten how wonderful they are.

People say there are no panaceas. They say technology cannot remake the world. But technology has remade the world time after time throughout history. Arthur C. Clarke published a marvelous speech about cold fusion in *"Cold Fusion"* magazine's first issue. In it, he concludes:

"With monotonous regularity, all throughout history, religious crackpots have predicted the imminent end of the world. I have about 90 percent confidence that I'm doing something very similar . . . And this time, it's good news."

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1. M. Fleischmann, S. Pons, and M. Hawkins, "Electrochemically Induced Nuclear Fusion of Deuterium." *J. Electroanalytical Chem.*, vol. 261, pp 301-308.

2. J. Maddox, "End of Cold Fusion in Sight," *Nature*, 340, 15 (1990).

3. F. Slakey (A.P.S.), "When the lights of reason go out—Francis Slakey ponders the faces of fantasy and New Age Scientists," *New Scientist*, Sept. 1993, p. 11.

4. Dr. Edmund Storms, "Warming up to Cold Fusion," *Technology Review* (MIT), May/June 1994, 19–29.

5. *Frontiers of Cold Fusion*; Proc. 3rd Int. Conf. Cold Fusion, Nagoya, 1992, ed. H. Ikegami (Universal Academy Press, Tokyo, 1993), p. iii, p. 681.

6. K. Matsui (MITI), "New Hydrogen Energy (NHE) Research Project in Japan," Proc. 4th Int. Conf. Cold Fusion, Maui, 1993, (EPRI).

7. M. Fleischmann (U. Southampton), S. Pons (IMRA), "Calorimetry of the Pd-D2O system: From simplicity via complications to simplicity," *Phys. Lett. A.*, 176 (1993) 118-129

8. F. Piantelli (U. Siena), "Anomalous Heat Production in Ni-H Systems," *Il Nuovo Cimento*, Vol. 107 A, N, J. 163–167; also, lecture at U. Sienna, Feb. 14, 1994.

9. S. Pons, M. Fleischmann (IMRA), "Heat After Death," Proc. 4th Int. Conf. Cold Fusion, Maui, 1993, (EPRI)

10. T. Mizuno et al (Hokkaido U.), "Anomalous Heat Evolution from SrCeO3-Type Proton Conductors During Absorption/Desorption of Deuterium in Alternate Electric Field," Proc. 4th Int. Conf. Cold Fusion, Maui, 1993, (EPRI)

11. Estimate from Peachtree Heading & Air-conditioning, Atlanta GA, for HVAC systems with all "bells and whistles," including installation but not duct work. $7,000 is for a medium size house; $14,000 is for a five-ton system, suitable for a very large house.

12. G. R. Davis, "Energy for Planet Earth," *Scientific American*, September 1990, 55-62.

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Mr. Rothwell's talk was before The Global Super Projects Conference & Exhibition was held in Barcelona, Spain from June 19-22, 1994. The theme was "Building Teams for Billion-Dollar Projects." Eleven sessions were held, with titles such as: "Team Building for Attracting and Developing Industrial Super Projects; Building Teams for Large Global Events [including the Olympics]; Building Teams for Water and Energy Projects; Telecommunications; and Building the New Global Data Highway."

The conference was sponsored by the World Development Council (WDC), which is headquartered in Norcross, Georgia, a suburb of Atlanta. The WDC is a non-profit, non-governmental organization of corporations and agencies that focus on large-scale super projects: things like civil engineering, airports, dams, highways, and advanced telecommunications networks.

This was the third annual Global Super Project Conference. Previous conferences have focused on individual projects such as the proposed Motorola Iridium satellite communication network and the Kansai International Airport. Previous conferences have attracted a broad range of participants from companies and organizations ranging from architecture firms to large corporations like AT&T, Bechtel International, Inc., China State Construction Co., NASA, and NEC. Previous speakers have included Ross Perot and Robert McNamara. Some two hundred participants attended in 1994.

The WDC chairman is Mr. McKinley Conway, president of Conway Data, Inc, which specializes in publications, information, and association management related to the fields of economic development and corporate expansion. It publishes a family of magazines, books and reports on these subjects. The WDC likes to invite a few challenging, futurologists to the conference, so in April it asked the world's leading futurologist, Arthur C. Clarke, who he might recommend for this year's conference. Clarke suggested Jed Rothwell. In a connection forged by fax from Atlanta to Sri Lanka and back to Atlanta, the WDC contacted Rothwell, who lives just down the street.

[Ed: Figures have been omitted, but captions are included.]

Figure 1. This graph shows1992 data from Pons and Fleischmann, the temperature of a cell that was driven to boiling by heat from the cold fusion reaction. At this stage, all of the electrolyte has boiled out, and the connection between anode and cathode is

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broken, so no additional electrical energy can go into the cell. As the graph demonstrates the apparatus stays hot for three hours. This phenomenon is known as "heat after death" or "a fully ignited, self-sustaining" reaction.

MIT's *Technology Review* ran as its cover story in the May/June 1994 issue a lengthy feature by Dr. Edmund Storms (Los Alamos National Laboratory, retired) titled, "Cold Fusion Heats Up." The piece claimed that " . . . the basis for skepticism is dwindling as reports of energy-releasing nuclear reactions at room temperature pour in from labs around the world."

Figure 2. Japan's Ministry of International Trade and Industry announced at the Third International Conference on Cold Fusion, 1992, in Nagoya, expanded support for research, including a new dedicated lab and a $30 million, four-year program.

Figure 3. This graph shows data from Mizuno et al. of Hokkaido University. Hours after the reaction begins, the cell temperature is 400°C. The calibration shows that if there were no reaction the temperature would be 270°C—a gigantic difference of 130°C.

Basic Information Resources

Books

• *Fire from Ice: Searching for the Truth Behind the Cold Fusion Furor* by Eugene F. Mallove, (John Wiley & Sons, May, 1991). First book to conclude that evidence for the cold fusion was "overwhelmingly compelling."

• *Cold Fusion Impact — In the Enhanced Energy Age* by Hal Fox, Editor of Fusion Facts (1992). A brief assessment of the potential impact of cold fusion and other "enhanced" energy technologies.

• *Fusion Energy: Hearing Before the Subcommittee on Energy of the Committee on Science, Space, and Technology*, U.S. House of Representatives, 103rd Congress, First Session, May 5, 1993. Vol.38, Cold fusion testimony and many scientific papers entered into the record! (For sale by the U.S. Government Printing Office, Superintendent of Documents, Congressional Sales Office, Washington, DC 20402 ISBN 0-16-041505-5)

• *Cold Fusion: The Making of a Scientific Controversy* by F. David Peat, Contemporary Books, 1989, 1990. A neutral, quick overview of cold fusion.

• *Too Hot to Handle* by Frank Close (1991). A negative view of cold fusion, covering mainly events through the end of 1989.

• *Cold Fusion: Scientific Fiasco of the Century* (1992) by John Huizenga, former co-chairman of the Panel on Cold Fusion for the United States Department of Energy. The highly premature 1989 report from Huizenga's panel put an end to DOE cold fusion funding.

• *Bad Science: The Short Life and Weird Times of Cold Fusion* (1993) by Gary Taubes. Like Huizenga, Taubes promotes the notion that cold fusion research is "pathological science" and fraud.

Key Compendia and Reviews:

• Dr. Edmund Storms (Los Alamos National Laboratory), "Review of Experimental Observations About the Cold Fusion Effect," *Fusion Technology*, 1991, Vol.20, December, 1991, pp.433-477.

• Dr. M. Srinivasan (Bhabha Atomic Research Centre, Bombay, India), "Nuclear Fusion in an Atomic Lattice: Update on the International Status of Cold Fusion Research," *Current Science*, 25 April 1991.

• "A Review of the Investigations of the Fleischmann-Pons Phenomena," John O'M. Bockris, Guang H. Lin, and Nigle J.C. Packham, *Fusion Technology*, Vol.18, August 1990, pp.11-31.

• *BARC Studies in Cold Fusion* (April-September 1989), Bhabha Atomic Research Centre, BARC - 1500, December, 1989, P.K. Iyengar and M. Srinivasan; also in *Fusion Technology*, Vol.18, August 1990, pp.32-94.

• *First Annual Conference on Cold Fusion (March 28-31, 1990): Conference Proceedings* , by the National Cold Fusion Institute, Salt Lake City.

• *Anomalous Nuclear Effects in Deuterium/Solid Systems*, American Institute of Physics Conference Proceedings 228, 1991, Steven E. Jones, Franco Scaramuzzi, and David Worledge (editors), Proceedings of an International Progress Review on Anomalous Nuclear Effects in Deuterium/Solid Systems, Brigham Young University, Provo, Utah, October 22-24, 1990. (approx. 1000 pages)

• *Investigation of Cold Fusion Phenomena in Deuterated Metals* (four volumes), by the National Cold Fusion Institute (Salt Lake City), June 1991, now available from NTIS.

• *The Science of Cold Fusion:*

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Proceedings of the II Annual Conference on Cold Fusion, June 29 - July 4, 1991, Como, Italy, published by the Italian Physical Society, Bologna, Italy, 1991, edited by T. Bressani, E. Del Giudice, and G. Preparata (528 pages).

• *Frontiers of Cold Fusion, Proceedings of the Third International Conference on Cold Fusion (Nagoya, Japan 21-25 October, 1992)*, edited by Dr. Hideo Ikegami, National Institute for Fusion Science, Nagoya 464-01, Japan.

• *Proceedings: Fourth International Conference on Cold Fusion* (December 6-9, 1993, Lahaina, Maui, Hawaii), published by the Electric Power Research Institute (EPRI), the conference was sponsored by EPRI and the Office of Naval Research. Four volumes of the proceedings edited by Thomas O. Passell (EPRI). A large selection of papers from the Proceedings were peer-reviewed and published in a dedicated issue of *Fusion Technology*, December 1994, Volume 26, No.4T, part 2, 535 pages.

• *Cold Fusion Source Book: International Symposium on Cold Fusion and Advanced Energy Sources*, Belarusian State University, Minsk, Belarus, May 24-26, 1994. Edited by Hal Fox, published by Fusion Information Center, Salt Lake City.

• *A Critical Review of the "Cold Fusion Effect,"* Edmund Storms, December 1994, in preparation for submission to a major physics journal (60 pages).

• "Cold Fusion Research in Italy," Scaramuzzi, F., Proc. Third International Conference on Cold Fusion, October 21-25, 1992, Nagoya Japan, *Frontiers of Cold Fusion*, (H. Ikegami, ed), p. 353.

• "Cold Fusion Researches in Russia," Tsarev, V., *Proc. Third International Conference on Cold Fusion*, October 21 -25, 1992, Nagoya Japan, *Frontiers of Cold Fusion*, (H. Ikegami, ed), p. 341. And, "Cold Fusion Studies in the USSR," Tsarev, V., *Proc. of the Second Annual Conference on Cold Fusion*, Como, Italy, June 29—July 4, l991, *The Science of Cold Fusion*, Vol. 33 (T. Bressani, E. Del Giudice and G. Preparata, eds), p. 319.

• "Chinese Effort in Understanding the "Cold Fusion" Phenomena," Li, X. Z., *Proc. of the Second Annual Conference on Cold Fusion*, Como, Italy, June 29--July 4, 1991, *The Science of Cold Fusion*, Vol. 33 (T. Bressani, E. Del Giudice and G. Preparata, eds), p.309. And: "Cold Fusion Researches in China-From Confirmation to

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Analyzing the Mechanism," Li, X. Z., *Proc. Third International Conference on Cold Fusion*, October 21-25, 1992, Nagoya Japan, *Frontiers of Cold Fusion*, (H. Ikegami, ed), p. 337. Zhong, L. X., "Searching for Truth With High Expectations- 5 Year Studies on Cold Fusion in China,"*Proc. Fourth International Conference on Cold Fusion*, Lahaina, Maui, Dec. 6-9, 1993.

Reliable Publications

• *Fusion Technology*, the technical journal published by the American Nuclear Society, formerly was exclusively devoted to hot fusion. Since September 1989, this journal has regularly had an extensive section devoted to cold fusion.

• Among several other technical journals that have continued to carry cold fusion articles are: *Physics Letters A*, *The Japanese Journal of Applied Physics* and *The Journal of Electroanalytical Chemistry*, where the first cold fusion paper appeared.

• *Fusion Facts*, a cold fusion newsletter published by the *Fusion Information Center* in Salt lake City, edited by Hal Fox (P.O. Box 58639, Salt Lake City, UT 84158).

• *Cold Fusion Times*, (Wellesley Hills, MA), a quarterly newsletter since 1993, edited by Dr. Mitchell R. Swartz (P.O. Box 81135, Wellesley Hills, MA 02181).

• *New Energy News*, Monthly Newsletter of the Institute for New Energy (Cold Fusion as well as other over-unity devices), Hal Fox, Editor, (P.O. Box 58639, Salt Lake City, UT 84158-8639).

• *"Cold Fusion"* Magazine, issues No.1, 2, and 3 (May, June, July/August 1994), edited by Eugene Mallove, Jed Rothwell, Chris Tinsley, and Larry Forsley. (Continued as an unreliable newsletter by its original publisher now thought to be discontinued.)

• *21st Century Science and Technology* (Leesburg, VA) quarterly journal, has been providing accurate coverage of cold fusion (60 Sycolin Rd., Suite 203, Leesburg, VA 22075).

Popular Articles and TV/Radio Programs of the Last Few Years

Radio and TV:

• "Good Morning America," ABC TV Science editor Dr. Michael Guillen covered the Patterson Power Cell on February 7, 1996, approximately 6 minutes.

• Nightline, ABC TV Science editor Dr. Michael Guillen covered the Patterson Power Cell — a 30 minute program also on February 7, 1996.

• "It Runs On Water," by Channel 4 in England, 50 minute program dealing with various over-unity devices including the Patterson Power Cell, December 17, 1995.

• BBC (British Broad-casting Corporation), "Too Close to the Sun," a 50-minute Horizon program broadcast in the UK and Europe on March 21 and 26, 1994, a positive overview of the history and status of cold fusion. A slightly different version of "Too Close to the Sun" was broadcast in Canada, also in the spring of 1994, by the co-production organization, the CBC (Canadian Broadcasting Corporation).

• CBC (Canadian Broadcasting Corporation) "The Secret Life of Cold Fusion," a balanced 30-minute documentary of cold fusion, June 24, 1993.

• "Good Morning America," ABC TV Science editor Dr. Michael Guillen produced the first U.S. nationally broadcast science television program on cold fusion since the early days of the controversy. On May 31, 1994, GMA aired a 10-minute segment in which Fleischmann and Pons were interviewed in their laboratory in France.

• "Science Friday," a National Public Radio program hosted by Ira Flatow has provided continuing updates on cold fusion research, e.g. program of June 25, 1993 and March 11, 1994.

• NOVA, "Confusion In a Jar" (1990), a confused, highly-negative view of the early history of cold fusion.

Print Media (U.S. and U.K. only):

• *Analog Science Fiction and Fact,* January 1995, Editorial: "Cold Fusion Conundrum," by Stanley Schmidt, pp.4-10.

• *Boston Globe*, April 17, 1992, p.7, "Making the case for 'cold fusion'"

• *Business Week*, March 2, 1992, p.90,92, "Cold Fusion Isn't Dead in the Water Yet"

• *Business Week*, October 26, 1992, p.88, 90, "Power in a Jar: The Debate Heats Up"; and an Editorial, p.120, "A Warming Reception for Cold Fusion"

• *Business Week*, November 9, 1992, p.109, "Two More Telltale Signs of Cold Fusion"

• *Chemical & Engineering News*, April 6, 1992, p.6, "Cold Fusion Takes a Licking but Keeps on Ticking."

• *Final Frontier*, June 1994, guest editorial on cold fusion by Eugene Mallove.

• *New York Times*, November 17, 1992, C1, C12, "Cold Fusion, Derided in U.S., Is Hot in Japan"

• *Newsweek* (a special "Focus Update" edition with added science coverage, received by tens of thousands, but not all, subscribers), July 19, 1993, "Cold, But Not Dead—Scorned as bad science, cold fusion makes a comeback"

• *The (London) Observer*, December 6, 1992, "Western skeptics hand Japan clean energy on a plate."

• *Popular Science*, August 1993, "Cold Fusion: Fact or Fantasy," cover story by Jerry Bishop, science editor of the Wall Street Journal..

• *Science*, April 24, 1992, p. 438, "A Japanese Claim Generates New Heat"

• *Science*, July 24, 1992, p.474, "Where There's Heat There's Yen"

• *Science*, October 2, 1992, p.35, "The Many Lives of Cold Fusion."

• *The Sunday Times (London)*, June 27, 1993, "Storm in a Bucket—What happened to the 'greatest scientific discovery of the century'

• *Technology Review* (MIT), May/June 1994, "Warming Up to Cold Fusion," by Dr. Edmund Storms, Los Alamos National Laboratory (a cover story)

• *Technology Review* (MIT), August /September, Letters to the Editor responding to Dr. Storms' article

• *USA Today: The Magazine of the American Scene* (NOT the newspaper of the same name!), "The Resurrection of Cold Fusion," by Dr. Mary Marcus, pp.55-57.

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Cold fusion did not arrive "out of the blue." It is part of the history of science, the history of physics, the history of chemistry, the history of technology, and the history of hot fusion. Here is an eclectic view of the place of cold fusion in the larger history of science. Highlights of the years 1989 through the present are provided in more detail:

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Seminal Articles Continued on page 116

Highlights of Cold fusion History: A Time-Line

• Greek philosophers Leucippus of Miletus and his student Democritus declare that the world is composed of indivisible particles — atoms.

500 B.C. - 1800 A.D. (Still alive and well into 20th century.)

• The age of alchemy, attempts to transmute base metals into gold or into an elixir for immortality. (Some forms of cold fusion circa 1989— appear to involve transmutations at low energy conditions, in reactions previously thought to be impossible.)

1803

• British chemist John Dalton puts forth his *atomic theory*, which suggests that each element is composed of identical atoms whose properties determine the chemical reactivity of that element.

1816

• British physician William Prout suggests that all atoms are composed of hydrogen atoms.

1854

• German physicist Hermann Ludwig Ferdinand von Helmholtz suggests that the gravitational contraction of the Sun may explain its release of energy and emission of radiation.

1868

• Discovery of the element, helium, in the light spectrum of the Sun by Pierre Janssen and Joseph Norman Lockyer.

1869

• Russian chemist Dmitri Ivanovich Mendeleev proposes the periodic table of the elements, organizing the chemical elements according to their chemical properties.

1895

• Sir William Ramsay isolates the element helium in a uranium-bearing mineral.
• Serendipitous discovery of x-rays by Wilhelm Conrad Roentgen. Lord Kelvin's initial reaction is that the reports are a hoax.

1896

• The discovery of radioactivity by French physicist, Henri Becquerel..

1897

• Physicist Joseph John Thomson establishes the existence of electrons as extremely low mass carriers of negative electric charge. He suggests that electrons are embedded like raisins in the positively charged body of an atom.

1904

• Physicist Ernest Rutherford suggests that gravitational energy is inadequate to explain the energy release by the Sun.

1905

• Einstein proposes his theory of Special Relativity in which mass and energy are shown to be equivalent. The theory includes the famous relation $E=mc^2$.

1906-1908

• By bombarding materials with alpha particles from radioactive elements. Physicist

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Ernest Rutherford in England develops the concept that an atom has a tiny, dense nucleus.

1909

• Rutherford identifies alpha particles as the nucleus of the helium atom.

1911

• Dutch physicist Heike Kammerlingh Onnes discovers the phenomenon of superconductivity in the element mercury chilled to 4.12 K. Superconductivity would later play a role in developing magnetic confinement fusion, and "high temperature superconductivity" would emerge only two years before the Utah cold fusion announcement in 1989.

1915

• American chemist William Draper Harkins suggests the possibility of fusing hydrogen atoms to produce helium, with a fraction of a percent of the original mass being converted to energy.

1919

• Rutherford transmutes nitrogen to oxygen in his alpha particle bombardment experiments— the first (known, confirmed) transmutation of elements accomplished by human beings. (Later confirmed by British physicist Patrick M.S. Blackett.)

1920

• Rutherford identifies the hydrogen nucleus as a fundamental particle, the proton.
• British astronomer Arthur Eddington demonstrates that the conversion of mass to energy could power the stars.

Early 1920s

• Irving Langmuir at General Electric Research Laboratory coins the term *plasma* for a partially ionized gas.

1926

• At the Chemical Institute of the University of Berlin, chemists Fritz Paneth and Kurt Peters investigate the possibility of transforming hydrogen to helium using a catalyst such as palladium. They claim to produce small amounts of helium by diffusing hydrogen through a capillary tube made of palladium. Report their results in two German scientific journals.

1927

• Building on the ideas of Paneth and Peters, chemist and physicist John Tandberg files a patent application in Sweden to use an electrochemical cell with a palladium electrode operating at high pressure to produce helium.
• After tests performed at Cornell University and in Berlin, Paneth and Peters formally retract their 1926 claims in two German journals as well as in *Nature*.
• John Tandberg's patent application is rejected because "the description is not complete enough that by its use an expert is likely to be able to practice the invention."

1929

• British astronomer, Robert Atkinson, and Austrian physicist, Fritz Houtermans, publish a speculative article suggesting a way for protons to fuse to form helium in a star via an intermediary "proton trap" nucleus.

1932

• Discovery of the neutron by British physicist James Chadwick.
• Chemist Harold Urey isolates the isotope of hydrogen, deuterium.
• John Tandberg in Sweden attempts to create nuclear fusion by electrolyzing heavy water with high energy electrical discharges in a palladium wire.

1934

• Australian physicist Marcus Oliphant and Austrian chemist Paul Harteck produce helium-3 by bombarding deuterium with deuterons.

1936

• Niels Bohr develops the liquid drop model of the nucleus.
• Physicist Carl Anderson at Caltech discovers the *mu meson* or *muon*., a particle that others would later use in *muon-catalyzed* cold fusion.

1938

• Otto Hahn and Fritz Strassman in Germany bombard uranium with neutrons and create the first man-made fission of an element. Lise Meitner, who had been working with Hahn before fleeing to Stockholm from Germany, identifies the process as fission.

1939

• Hans Bethe, Geroge Gamow, and Ralph Alpher publish detailed mechanism of fusion reactions powering the Sun.

1941

December 6

• President Roosevelt initiates the Manhattan nuclear bomb project.

1942

December 2 — 3:45 pm

• First self-sustaining fission reaction occurs in graphite pile built at the University of Chicago, under the direction of physicist Enrico Fermi.

1945

July 16 — 5:30 am

• Detonation of world's first nuclear bomb at Alamogordo, New Mexico.

1945-1946

• At Los Alamos, physicists Edward Teller, Robert R. Wilson, and Robert Cornog discuss magnetic confinement schemes for plasmas to create controlled fusion. James L. Tuck and Stanislaw Ulam collaborate on the idea of colliding high velocity beams of deuterium.

1946

• Sir George P. Thomson and Moses Blackman in England file a patent application for a toroidal fusion reactor using the *pinch effect*.

1949

• Explosion of first Soviet fission bomb triggers U.S. effort to develop the hydrogen bomb.

Late 1940s

• Physicists Andrei Sakharov in the Soviet Union and F.C. Frank in England independently suggest the possibility of muon-catalyzed cold fusion.

1951

• Argentine dictator Juan Perón makes worldwide headlines by announcing that a German scientist working for him has invented controlled fusion. Perón suggests that within months Argentina will have a full-scale fusion power plant.
• Princeton University astronomer Lyman Spitzer, Jr., inspired by the Perón announcement, conceives the basic scheme of magnetic confinement of a plasma to produce controlled fusion.

1952

November 1

• Detonation of the world's first thermonuclear bomb by U.S. on the coral Pacific atoll, Elugelab.

1956

• Louis Alvarez and his colleagues at UC Berkeley accidentally discover muon-catalyzed cold fusion.

1958

• Harwell Weapons Laboratory in England announces success with a hot fusion experiment called "Zeta." Neutron measurements are found subsequently to be erroneous.

1965-1968

• Soviet scientists develop and announce their tokamak hot fusion reactor concept. Reaction in the West is extremely skeptical.

1969

• British measurements at a Soviet tokamak convince western scientists that the tokamak concept is really a breakthrough in magnetic fusion.

Late 1960s—Early 1970s

• Martin Fleischmann and his colleagues conduct research on the separation of hydrogen and deuterium isotopes, work that leads in the 1980s to cold fusion experiments.

Mid-to late 1970s

• Beginnings of inertial confinement (laser) fusion efforts.

1978

•Russian physicist B.A. Mamyrin observes anomalies in the concentrations of helium-3 and helium-4 in metals, work that later influences Steve Jones and his colleagues.

Late 1970s

• B. Stanley Pons examines isotopic separation in palladium electrodes and is puzzled by some of his results.

1980

• US Magnetic Fusion Energy Engineering Act of 1980 recommends a doubling of magnetic fusion budget within seven years.

1983

• Alcator C tokamak at MIT is the first tokamak to exceed the minimum Lawson parameter for breakeven (if fuel were deuterium-tritium).

1984

• Pons and Fleischmann begin their collaboration on an electrochemical experiment to search for evidence for cold fusion.

1985

• Geneva summit between Reagan and Gorbachev launches the ITER program to build an "International Thermonuclear Experimental Reactor" involving the US, USSR, Japan, and the European community.

1986

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April-May

• Stephen E. Jones of Brigham Young University and his colleagues begin planning cold fusion experiments with metals.
• Jones and Clint van Siclen publish paper on "piezonuclear fusion."

1987

• Johann Rafelski and Steven E. Jones publish an article in the July 1987 issue of Scientific American titled "Cold Nuclear Fusion." They describe the process of muon- catalyzed fusion reactions.

1988

• TFTR tokamak at Princeton attains a plasma temperature of 300 million degrees K. Both JET tokamak in England and TFTR closely approach breakeven conditions.

1989

February 23

• Pons and Fleischmann visit Jones's group at Brigham Young University . Jones mentions intent to publish an article on his research and to deliver his paper to the American Physical Society Meeting on May 4, 1989. Pons and Fleischmann want to spend more time—perhaps 18 months longer—on their experiments before going public.

March 11

• Pons and Fleischmann submit their paper on cold fusion to the *Journal of Electroanalytical Chemistry and Interfacial Electrochemistry*.

March 23

• Martin Fleischmann and B.. Stanley Pons announce at a press conference at the University of Utah in Salt Lake City that a "simple experiment results in sustained fusion at room temperature for the first time." The story is first reported by the *Financial Times* in England and the Wall *Street Journal* in the U.S. , triggering a media avalanche of coverage that lasts for months. Scientists around the world immediately begin efforts to confirm or reject the Utah claims.
• Stephen E. Jones submits his paper to *Nature*.

March 24

• Governor Norm Bangerter of Utah announces the convening of a special session of the state legislature to approve $5 million to start an institute for cold fusion research.

March - April

• Major cold fusion experimental efforts begin in Japan and India.

April 7

• Utah legislature passes cold fusion research legislation.

April 8

• The University of Utah legislature meets to consider $5 million appropriation for cold fusion research and development. Money is set aside, not to be used unless the University of Utah experiments are confirmed.

April 10

• Researchers at Texas A&M University claim to have duplicated the Pons and Fleischmann experiment (this one group's claim later is found to be a mistake).
• Researchers at Georgia Tech announce the detection of neutrons from an electrochemical cell. (A claim subsequently retracted, three days later.)
• Pons and Fleischmann paper on cold fusion appears in the *Journal of Electroanalytical Chemistry and Interfacial Electrochemistry*.

April 12

• Meeting of the American Chemical Society in Dallas, Texas, is attended by some 7,000 chemists; Pons defends the alleged fusion breakthrough.
• Peter L. Hagelstein at MIT announces his explanation of cold fusion as "coherent fusion." MIT announces that it has applied for patents related to Hagelstein's theories.
• Professor Keith Johnson of MIT's Department of Materials Science and Engineering announces his theory to explain the University of Utah results on the basis of "dynamical John-Teller" chemical bonding, while acknowledging that small amounts of nuclear fusion could be taking place in the palladium electrode. He is first to suggest publicly that heat may come from light water tests too.

April 14

• University of Utah chemistry professors Cheves T. Walling and John T. Simons announce their theory to explain the Pons-Fleischmann experiments.
• Georgia Tech researchers retract their claimed neutron detection.

April 17

• At a University of Utah press conference, Pons announces that results of mass spectroscopy reveals quantities of helium-4 are being produced by their electrochemical cells.

April 18

• Italian physicist Francesco Scaramuzzi,with a group at the Italian Atomic Energy Authority at Frascati claims success in detecting neutrons from cold fusion using a titanium metal infused under pressure with deuterium.
•Robert Huggins at Stanford University, says he has obtained excess heat in an electrochemical cell with heavy water, but not in one with light water.

April 24

• Secretary of Energy Admiral James Watkins establishes a review panel to evaluate cold fusion claims. Directs DOE's National Laboratories to conduct cold fusion research investigations

April 26

• Members of the U.S. House of Representatives Committee on Science, Space, and Technology hear request from the University of Utah for quick approval of $25 million to help commercialize their alleged fusion process.

April 27

• A paper by Steven E. Jones and seven colleagues appears in *Nature*, titled "Observation of cold nuclear fusion in condensed matter." Editorial by John Maddox in *Nature* is skeptical of Fleischmann and Pons cold fusion claims.

April 28

• Yale University - Brookhaven National Laboratory collaboration reports detecting no nuclear products from electrochemical cells after three weeks of trying.
• Researchers at Case Western Reserve University report excess heat and tritium generation in electrochemical cells.

May 1 and 2

• Researchers at MIT Plasma Fusion Center say they have found serious flaws in the neutron emissions data reported by Pons and Fleischmann; say that Pons and Fleischmann were unlikely to have detected neutrons. At a meeting of the American Physical Society in Baltimore, MD, physicists and chemists roundly criticize and mock the work of Pons and Fleischmann.

May 8

• At meeting of the Electrochemical Society in Los Angeles, Pons and Fleischmann defend their experiments against criticism, but back off on their claims to have detected neutrons.

May 18

• An extended scientific correspondence by researchers at MIT's Plasma Fusion Center appears in *Nature.*, critiquing the original Pons and Fleischmann neutron data and finding it to be flawed.

May 23-25

• The first conference dedicated exclusively to cold fusion is held in Santa Fe, New Mexico, and draws some 500 participants.

June 15

• Harwell Laboratory in England stops work on cold fusion experiments.

June 26

• Los Alamos National Laboratory scientists announce finding tritium in cold fusion experiments.
• MIT Plasma Fusion Center holds "Wake for Cold Fusion" party

June -Late

• Release of funding by Utah State Fusion Energy Advisory Council to establish the National Cold Fusion Institute

July 12

• Interim report by ERAB panel of DOE, finds no good evidence for cold fusion and rejects a formal research center for cold fusion.

October 16-18

• EPRI/NSF meeting on cold fusion in Washington, DC

October 19-20

• Electrochemical Society meeting, Hollywood, Florida, cold fusion session.

November 8

• Final DOE ERAB report approved concluding that evidence for cold fusion is not persuasive.

1990

March 28 -31

• First Annual Conference on Cold Fusion

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held in Salt Lake City is attended by over 200 researchers.

• Nature magazine (March 29) publishes scathing editorial attacks on cold fusion research and prints an article by University of Utah physicist Michael Salamon et al claiming that in 1989 tests they detected no nuclear products coming from Pons's cells.

June 15

• Publication in *Science* of a lengthy exposé by Gary Taubes in which he strongly suggests that high levels of tritium found in Texas A&M University cold fusion experiments were the result of fraudulent spiking of the cells.

July 23

• Bruce Liebert and Bor Yann Liaw and colleagues at the University of Hawaii report multi-watt excess power output from electrochemical cells incorporating molten salts and deuterium. Results reported at the cold fusion sessions of the World Hydrogen Energy Conference.

July 25

• A comprehensive paper on excess-heat measurements in electrochemical cells is published by Fleischmann, Pons, et al in the *Journal of Electroanalytical Chemistry*.

October 22-24

• Conference on "Anomalous Nuclear Effects in Deuterium/Solid Systems" at Brigham Young University. Major confirming evidence presented that finds energetic tritons in cold fusion experiments. Conference produces clinching proof that cold fusion can occur in deuterated systems without being catalyzed by muons.

November 7

• Review meeting in Salt Lake City of the Fusion Energy Advisory Council. Stanley Pons attends after returning from an alleged "disappearance" in Europe.

December, mid

• Review panel gives NCFI operations generally favorable critique.

1991

March 17

• Sunday *New York Times*, front page: Frank Close book, *Too Hot to Handle* profiled— accusations of ethical violations against Pons and Fleischmann.

March 22-26

• First Soviet National Conference on Cold Fusion, Dubna-Moscow. Research at 45 institutes reported, 80 papers submitted.

April 24

•Mayer-Reitz "hydron" theory of cold fusion announced.

• Randall Mills announces "shrinking hydrogen atom" (hydrino) theory and experimental evidence for significant excess heat in light water, nickel, potassium carbonate cells.

May, late

• Eugene Mallove's cold fusion book, *Fire from Ice: Searching for the truth Behind the Cold Fusion Furor*, is published.

June 29-July 4

• Second Annual Conference on Cold Fusion, Como Italy

June 30

• National Cold Fusion Institute closes.

August 18

•Eugene Mallove files formal request for investigation of mis-handling of data in 1989 MIT PFC cold fusion calorimetry experiment.

December 18

• Martin Fleischmann speaks at MIT on cold fusion research.

1992

January 2

•Andrew Riley killed in explosion at SRI during cold fusion experiment.

January 27

•ISEM, IEEE meeting of cold fusion researchers, Nagoya, Japan. Akito Takahashi of Osaka University reports massive excess heat and low-level neutrons

March

•Publication by Drs. Noninski of positive results in excess heat measurement in nickel, light water, potassium carbonate system.

April 1

• Eugene Mallove testifies favoring cold fusion research before Subcommittee on Energy and Water of the U.S. House Appropriations Committee.

• Final letter from President Vest closing MIT PFC calorimetry matter, without final resolution.

April 15

•Professor Akito Takahashi gives seminar at MIT on his heat and neutron-producing cold fusion experiments.

May

•MIT PFC publishes single-author "Technical Appendix" to sixteen-author 1989 cold fusion calorimetry experiment report, expands error limits.

July 10

• Japan's MITI announces major funding of cold fusion research.

July, mid

• Publication of John Huizenga's *Cold Fusion: Scientific Fiasco of the Century*.

July 27

•Edmund Storms of Los Alamos National Laboratory announces replication of Takahashi excess heat.

August

•Dr. Mitchell R. Swartz publishes "Reexamination of a Key Cold Fusion Experiment: 'Phase-II' Calorimetry by the MIT Plasma Fusion Center" in *Fusion Facts*. Analysis finds numerous faults in the analysis, as well as proof that data were inappropriately handled.

September 24

• McKubre of SRI speaks about excess heat results at MIT.

September, late

• Electrochemical Society Meeting in Japan; many excess heat reports.

October 21-25

• Nagoya Third International Conference on Cold Fusion. Numerous results confirm reproducibility of excess heat and nuclear phenomena.

November 17

• NTT Laboratories announces $565,000 "Cold Fusion Kit"

December 3-4, 9-10

• Dr. Reiko Notoya of Hokkaido University at MIT to demonstrate her light water cold fusion experiment.

1993

March 25

•Congressman Dick Swett (NH) and Eugene Mallove testify before the House Appropriations Committee, Subcommittee on Energy and Water to ask for funding for a National Academy of Sciences review of cold fusion.

May 5

•Fusion Energy Hearings before House Subcommittee on Energy of House Science, Space, and Technology Committee—Cold fusion researchers receive warm reception.

June

•Publication of Gary Taubes' *Bad Science: The Short Life and Weird Times of Cold Fusion*.

June 24

• World premier of Canadian Broadcasting Corporation's "The Secret Life of Cold Fusion."

August

•*Popular Science* publishes high-profile, objective account of latest cold fusion developments—a cover story.

September

•Hydrosonic Pump technology emerges as a significant probable excess-energy producing device. The horizons of the cold fusion field expand dramatically.

December 6-9

• Fourth International Con-ference on Cold Fusion, Maui, Hawaii, sponsored by the Electric Power Research Institute

• "Cold Fusion" Magazine is launched, initiated by Eugene Mallove, Jed Rothwell, Chris Tinsley, Larry Forsley, and others in the cold fusion field. Three issues are published. (All editors leave WGI publishing firm in June 1994 because of chaos in WGI management. Former editors begin preparations for new publication, *Infinite Energy*)

1994

February

•Piantelli-Focardi-Habel announce new ordinary hydrogen-nickel high temperature excess heat results.

March 21 and March 26

•Landmark CBC and BBC Programs on cold fusion: "Too Close to the Sun"

May 24-26

• International Symposium on Cold Fusion and Advanced Energy Sources, Minsk,

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Belarus.

May/June

• MIT *Technology Review* cover story, "Warming Up to Cold Fusion," by Dr. Edmund Storms

June

• Professor Keith Johnson of the MIT Department of Materials Science announces that his techno-thriller movie script, "Excess Heat," will become a feature produced by a major Hollywood studio.

October

•E-Quest Sciences announces large amounts of helium production in test of ultrasonic cold fusion reactor at Los Alamos National laboratory

•Y. Arata and Y.C. Zhang in Japan publish a new "double cathode" method of reliably producing the Pons-Fleischmann Excess Heat Effect

1995

January 21

• Cold Fusion Day at MIT— an IAP Program

April 9-13

•Fifth International Conference on Cold Fusion, Monte Carlo, Monaco

Summer 1995

• Experiments in Austin, Texas and Bow, New Hampshire fail to observe excess heat in Potapov Thermogenerator. Potapov mystery continues.

September

•European Patent Office gives notice that it will grant the Pons -Fleischmann Patent "Method and Apparatus for Power Generation."

October 1-5

•16th Biannual Symposium on Fusion Energy, SOFE '95 (Cham-paign, IL), CETI demonstrates Patterson Power Cell at 80:1 power ratio.

December 5-7

•CETI demonstrates Patterson Power Cell at Power Gen '95 in Anaheim, CA: 1,300 watts out, 1.4 watts in.

1996

January 20

•Cold Fusion & New Energy Symposium Sponsored by *In-finite Energy* Magazine at Cam-bridge Marriott Hotel

February 7

•ABC TV programs: "Good Morning America" and "Night-line" feature cold fusion and the Patterson Power Cell.

October 13-18

• Sixth International Conference on Cold Fusion, Hokkaido, Japan

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WASHINGTON WATCH

SURVEY LETTER to REPUBLICAN PRESIDENTIAL CANDIDATES

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February 9, 1996

Dear Senator Dole [or other candidate name]:

As the New Hampshire Primary approaches, you certainly have little time to spare! **But wait one minute....** what if I told you there was an issue that no candidate has yet addressed, yet which might well become one of the most important issues in the general election? Please take a few moments to consider the facts highlighted below —— then please answer the attached brief survey. We will publish the results of this survey of all the Republican candidates in the next issue of our Concord/Bow, New Hampshire-based magazine, which is read by concerned citizens, engineers, scientists, investors in every state of the union.

FACTS:

- Congressman Robert Walker, chairman of the House Science Committee made the following statement in the October 1995 issue of Popular Science:

> "One of the first bills to come out of my Committee was the Hydrogen Future Act. Hydrogen seems to be a potential energy source with benign environmental properties. **I'm also personally interested in the so-called cold fusion area. It's not fusion, obviously. But there's something that's producing additional heat, and it's being found in laboratory after laboratory.** No one at this point can explain it."

- On February 7, 1996, both ABC TV *Good Morning America* and *Nightline* featured one of the most significant developments in cold fusion since 1989 — the U.S. patented Patterson Power Cell, which has interested corporations such as Motorola. It is a device that produces hundreds of times more energy out than input, using water as fuel. This was extensively discussed on these programs. **Please read the attached transcripts!**

We also enclose one of the recent issues of our magazine. Please take a few moments to answer the survey questions so that we may report your responses in our next issue. Our readers want to know your views on policies that will affect the development of an energy source that in the near term will begin to affect every aspect of national and international life.

Sincerely,

Dr. Eugene F. Mallove

SURVEY

Presidential Candidate Name:
Senator Bob Dole

1. It is a matter of public record: Since 1989, the U.S. Department of Energy has seriously interfered with the open investigation and development of cold fusion energy, while favoring its $340 million /year wasteful and now doomed hot fusion program (The budget was reduced to $240 million recently). What would you do as President to reverse the present negative DOE policies —including the possible termination of DOE as a Federal Department?

2. How would you help the private sector in the U.S. accelerate the development of cold fusion energy?

3. In some cold fusion experiments, including several at Los Alamos National Laboratory, radioactive tritium gas has been produced from ordinary hydrogen. Since tritium is an ingredient in nuclear weapons, it appears that at least some aspects of cold fusion may have direct bearing on military security. What will you do to address these national security issues of cold fusion without hampering the civilian development of this technology?

4. Do you favor a Congressional investigation of how it came to be that a major U.S. scientific and technological discovery was brushed aside, devalued, and retarded in its development by an academic/DOE Government-complex bent on serving its own interests?

As of mid-March 1996, not a single one of the following presidential candidates has repsonded to the survey — surprise, surprise!

Governor Lamar Alexander
Patrick Buchanan
Senator Bob Dole
Congressman Robert Dornan
Steve Forbes
Senator Phil Gramm
Alan Keyes
Richard Lugar
Morry Taylor

However, Senator Arlen Specter, who dropped out of the race early on, did respond to a written and oral query by Editor Eugene Mallove, made *in-person* when Senator Specter was in Concord, New Hampshire in the fall:

Senator:

I'm an engineer and the editor of the magazine, *Infinite Energy*, published here in Concord and Bow. I'll also be voting in the Republican primary and am delighted that you are here today.

I'd like to hear your views about the U.S. Department of Energy, and what is to be done about its notorious waste and fraud. Specifically, what will you do to redress the scandal by DOE against the most important energy issue in the world today—New Hydrogen Energy, as it is called in Japan in a now $100 million/year program, or "cold fusion," as it is affectionately known in the United States. This completely proved technology that is now reaching commercialization has been given zero funding by DOE since its announcement in 1989, while the bankrupt hot fusion program has wasted billions of tax dollars on a white elephant going nowhere. Just to give you some background: the Republican Congress cut hot fusion from $350 million to $240 million a year, but it should be zeroed. In your state in Lancaster there are two companies working successfully on cold fusion, but the unethical, probably illegal behavior of DOE has prevented them from becoming even more prominent.

Both Senator Dole and Congressman Robert Walker of your state and Chairman of the House Science Committee have already told us that they are aware of this problem. Congressman Walker made a most welcome statement favoring cold fusion in the October issue of *Popular Science*. Clinton and Gore have only perpetuated the Heavy Watergate Scandal -- Clinton did not fulfill his

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promise to us in this very room in 1992 to reassess cold fusion. One of the things I'd like you to respond to is whether Hazel O'Leary should be forced do resign — not just for her "enemies list," but because of incompetence.

Senator, what will you do as a Senator and as President against DOE to help the United States fulfill its position as the originator of this technology and the nation that can begin to end the Fossil Fuel Age this decade with sustainable New Hydrogen Energy?

Thank you! — Eugene Mallove

Response Letter from U.S. Senator Arlen Specter of Pennsylvania

U.S. Senator Arlen Specter
Republican, Pennsylvania

December 21, 1995

Dr. Eugene F. Mallove
Editor-in-Chief and Publisher
INFINITE ENERGY
P.O. Box 2816
Concord, NH 03302-2816

Dear Dr. Mallove:

Thank you for expressing your interest in the development of New Hydrogen energy, or cold fusion, as it is commonly known. I appreciate learning of your thoughts on this subject.

As you know, our current reliance on fossil fuels and nuclear fission to supply our energy needs is limited and has substantial environmental costs. Therefore, it is important that we continue our research efforts for developing other potential energy producing methods. The federal government is currently involved in supporting research efforts for various types of energy research ranging from renewable resources such as solar, wind, and hydropower to nuclear fusion. It is my understanding, however, that uncertainty surrounding the concept of cold fusion, due to the inability of researchers to replicate the occurrence of cold fusion energy production, still exists. Accordingly, the Department of Energy has not requested funding for cold fusion research this year.

As you may know, cold fusion research data from Japanese researchers is expected to be shared with a U.S. research institute (Electric Power Re-search Institute), which uses the services of the Stanford Research Institute in Palo Alto, California. I am hopeful that such cooperation will help in determining the future potential for cold fusion technology, which has been patented by the University of Utah.

You may be interested to know that in light of our fiscal restraints, the Fiscal Year 1996 Energy and Water Development Appropriations bill reduced "hot" fusion energy research by $128.6 million below last year's level. I believe that the continuation of some funding for this program, however, is necessary to allow us to explore all potential options for our future energy supply. Be assured that I will keep your interest in cold fusion research in mind when Congress again reviews energy research funding during the Fiscal Year 1997 Appropriations process.

Again, thank you for contacting my office. Please continue to keep me apprised of your views on this or any other matter of mutual concern.

Sincerely,

Arlen Specter

For an Excellent Introduction to Cold Fusion and New Energy Technology.....

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MIT COLD FUSION DAY- January 21, 1995

at the Massachusetts Institute of Technology

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TAPE#1

Dr. Eugene F. Mallove
(Cold Fusion Technology, Concord, NH)
"Cold Fusion and New Energy Technology-An Overview"
Dr. Peter Graneau
(Northeastern University Center for Electromagnetic Research) "Anomalous Forces in Water Plasma Explosions"

TAPE#2

Buford ("Ray") Conley
(MIT, graduate student, Dept. of Aero/Astro Eng.)
"Light Water Excess Heat Experiments"
Fred Jaeger
(ENECO, Salt Lake City)
"Patents and Commercialization"
Professor Peter L. Hagelstein
(MIT Dept. of Electrical Engineering and Computer Science) "Cold Fusion: What We Know and What We Don't Know"

TAPE#3

Professor Peter Hagelstein
(CONTINUED from TAPE #2)
"Cold Fusion: What We Know and What We Don't Know"
Professor Keith Johnson
(MIT Dept. of Materials Science and Engineering)
"Progress in the Theory of Excess Heat" *and Excess Heat*- The Movie, now being made by Hollywood!
James L. Griggs
(Hydro Dynamics, Inc., Rome, Georgia, USA)
"The Hydrosonic Pump: Excess Power and Other Effects"

TAPE#4

Bertil Werjefelt
(PolyTech(USA), Hawaii)
"Energy from Magnetic Materials and Magnetic Fields"
Dr. Eugene F. Mallove
(Cold Fusion Technology, Concord, NH)
Concluding Remarks

The tapes include the speakers' presentations as well as question and answer sessions. There is footage of the Hydrosonic Pump under test as well as close-up footage of rotor surface melting effects. Bertil Werjefelt shows footage of experiments in his own laboratory. There are scenes of Japanese researchers from Sumitomo, Hitachi, and other companies and universities now involved in their claimed extraction of energy from magnetic materials. These efforts are now said by these researchers to be proceeding toward commercialization. Actual experiments are seen in progress. The tapes are VHS cassettes in NTSC format and range from 120 to 127 minutes each.

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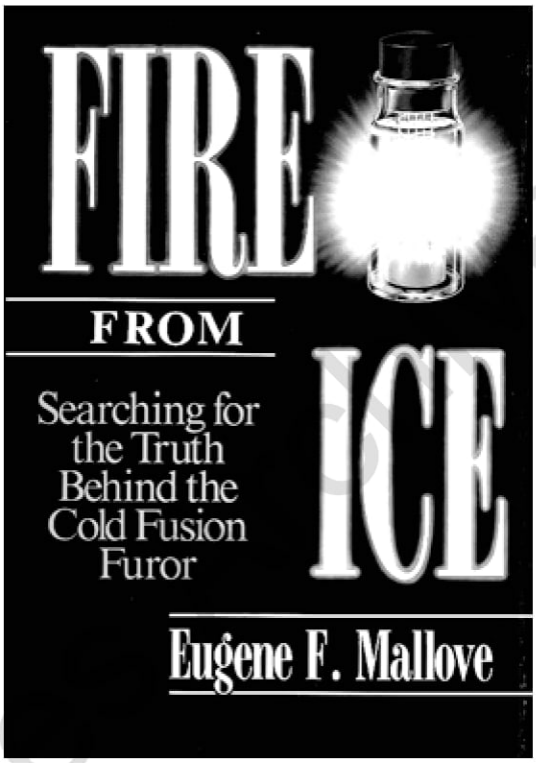
Read *The* Book on the Cold Fusion saga ...

Fire from Ice: Searching for the Truth Behind the Cold Fusion Furor

By Eugene F. Mallove, Sc.D.
Published by John Wiley & Sons, Inc., 1991, 334 pp.



A timeless treatment of the greatest scientific drama of our age..Nominated for a Pulitzer Prize in 1991

Critical Acclaim for Fire from Ice:

"Eugene Mallove has produced a sorely needed, accessible overview of the cold fusion muddle. By sweeping away stubbornly held preconceptions, he bares the truth implicit in a provocative variety of experiments."
—JulianSchwinger
Nobel Laureate in Physics

"Fire from Ice is the only good book on the subject...." *—Arthur C. Clarke*

... "Fire from Ice is a masterpiece of science documentation. Progress in deciphering the cold fusion effect is now stalemated by an establishment pressure for conformity. An authoritative book needed to be written, and it had to come from someone with roots in both the science and the journalism communities; there were very few people in the world as qualified as Eugene Mallove is to write it and give the story the meticulous attention it required.

"I think history will remember cold fusion like the "cat's whisker" [crystal] radio; the transistor could have been invented in 1924, if the science establishment had made an effort to understand it. If it takes less than four decades to understand this electrochemical effect, whatever it will ultimately be called, Eugene Mallove's book will deserve a large fraction of the credit."
— Dr. Henry H. Kolm, Engineer and industrialist, Co-Founder of MIT's Francis Bitter National Magnet Laboratory

"Mallove brings dramatically to life the human side of this important scientific controversy, which has tapped the emotions of its scientific participants in a way usually typical only of major scientific revolutions. Fire from Ice is highly recommended reading for anyone who is interested in the nature of scientific controversy and scientific change. I frankly could not put the book down once I had started it."
— Dr. Frank Sulloway, former MacArthur Fellow Science Historian, MIT Program in Science, Technology, and Society

"Not only is it the best thing that I have read about this subject, but it is also quite the best book of this type I have ever read."
—Professor John O'M. Bockris, Dept. of Chemistry Texas A&M University

"I highly appreciate your spirit in searching for the truth behind the cold fusion furor...Cold Fusion research will continue in China no matter how difficult it will be, since we realize that this is very important for the world's energy shortage and for third world countries that need energy and lack research funding."
—Professor of Physics Xing Zhong Li, Tsinghua University, Beijing, Head of the Chinese Fusion Power Program

"Your timely book provided the balanced and coherent overview I had been looking for. Cold fusion is an exciting field, and every physicist wishes he/she were taking part in it. After reading your book, I almost feel as if I am."
—Lee Pritchard, Dept. of Physics, Oakland University, Rochester,Michigan

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— Thea Singer, The Boston Phoenix

"A magnificent book on cold fusion. The language is elegant, the personalities come alive, and the premises are realistic. The number of references is staggering. How could he find the time to read them all, and still live a normal life?"
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Infinite Energy

Cold Fusion and New Energy Technology

(ISSN 1081-6372)

Eugene F. Mallove, Sc.D., Editor-in-Chief and Publisher

INFINITE ENERGY magazine premiered with the March/April 1995 issue, which was distributed to the participants of the Fifth International Conference on Cold Fusion (ICCF5), held in Monte Carlo, Monaco (April 1995). The May/June 1995 issue was sent to many hundreds of current subscribers, journalists, and libraries. Issues #3, July/August 1995, and #4 (Sept./Oct. 1995) had an even larger audience. The magazine now has limited distribution on select U.S. newsstands and is expected to expand greatly. *IE* is presently subscription-driven through ads in national U.S. magazines.

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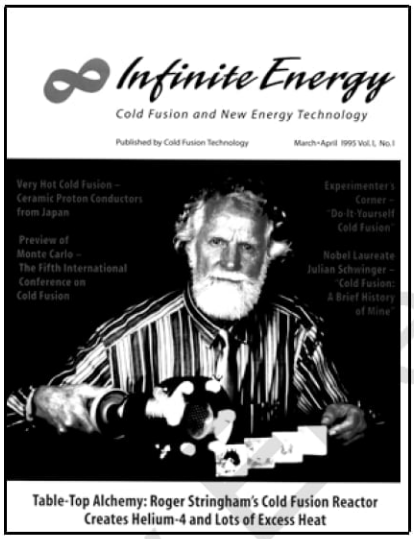

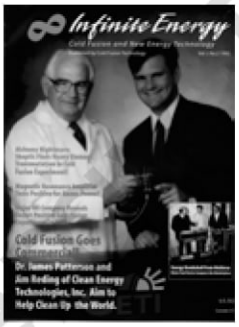

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